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TRANSPORTATION SAFETY RECOMMENDATIONS

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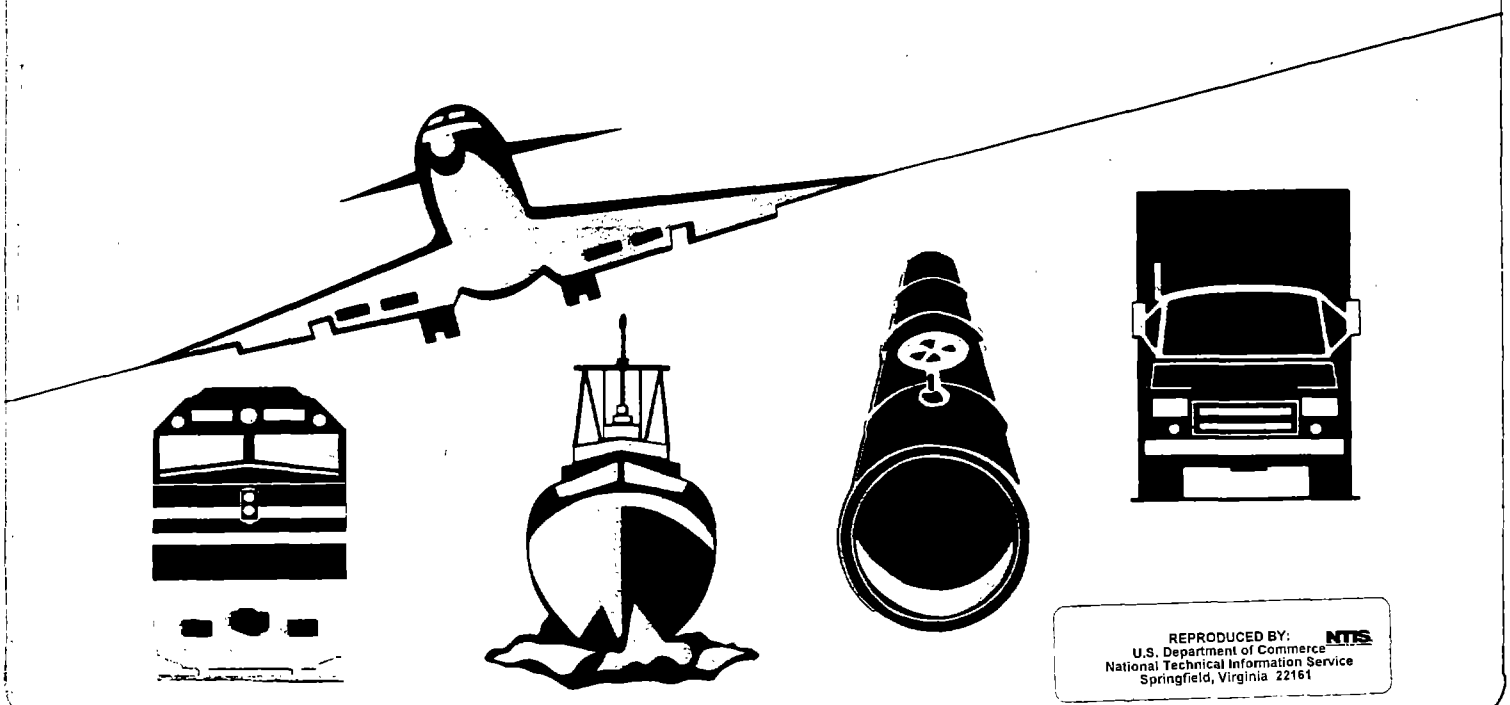

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16. Abstract

This publication contains safety recommendations in aviation, highway, marine and railroad modes of transportation adopted by the National Transportation Safety Board during the month of February, 1998.

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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 3, 1998
In reply refer to: A-98-6

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On August 20, 1997, the left outboard aileron of a Boeing 747-312 (747), operating as Ansett Airlines flight 826, deflected to the full-down position while the airplane was taxiing for takeoff at Brisbane International Airport, Brisbane, Australia. Postincident examination of the aileron control system was conducted by the Bureau of Air Safety Investigation (BASI), Commonwealth of Australia. The examination revealed that one of the left aileron cables (AA-11) that connect the inboard aileron quadrant to the aileron cable drum was broken. An adjacent cable (AB-13) that connects the aileron cable drum to the outboard aileron quadrant via a turnaround pulley was frayed. The aileron cable drum forward guide pin exhibited signs of wear consistent with abrasion by an aileron control cable. The airplane was manufactured in 1983, production line number 590, serial number (S/N) 23029, and had 11,027 cycles and 62,399 hours since new. The airplane had been operated 1,022 flight hours since both cables were replaced on June 2, 1997.

The 747 aileron control system comprises a cable loop system and hydraulic aileron actuators. Rotation of the cockpit control wheel moves cables routed along the rear spar of the wings to provide control inputs to inboard and outboard aileron power control units (PCUs).

Each wing has two AA and two AB aileron cable assemblies (see Figure 1.), one inboard and one outboard. The inboard AA cable run connects the aileron programmer quadrant to the aileron cable drum, and the inboard AB cable run connects the same quadrant to the inboard aileron PCU quadrant. The outboard AA cable run connects the aileron cable drum to the outboard aileron quadrant, and the outboard AB cable run connects the drum to the same quadrant via a turnaround pulley. The aileron cable drum, which is located at wing station (WS) 776.98, is a four-slotted pulley with a guide pin and is used to provide a complete (closed) cable loop to the inboard aileron even if the outboard segment is lost because of malfunction. The guide pin's purpose is to ensure that all four cables remain in the correct pulley slots at all times.

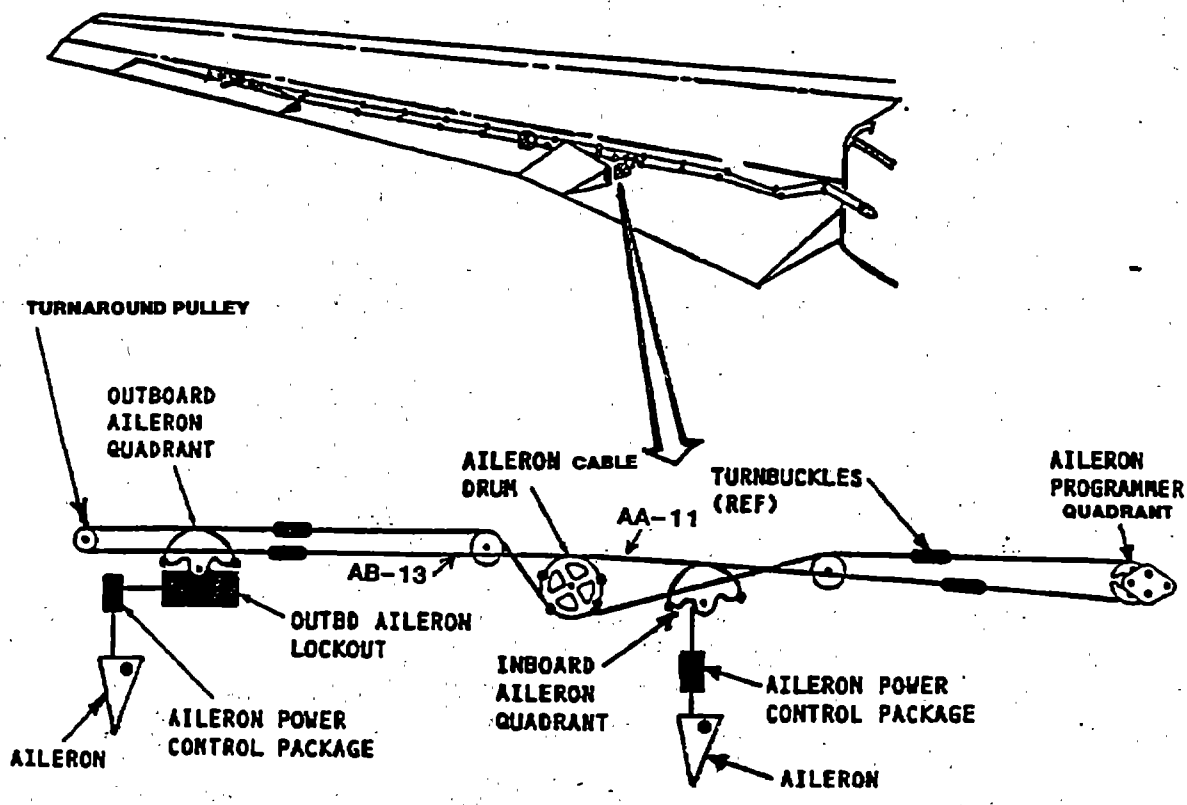


Figure 1. Aileron Wing Control Cable System.

Further investigation by BASI revealed that the two aileron control cable decals[1] on the aileron cable drum's inboard and outboard mounting brackets at WS767 and WS780 were installed incorrectly. The decal for WS767 was fitted at WS780 and vice versa. BASI also found that a similar 747 aircraft, S/N 23028, production line number 584, had the aileron cable replaced because of excessive wear, and the cable was frayed down to one remaining strand. This aircraft also had the two aileron control cable decals on the aileron cable drum's inboard and outboard mounting brackets at WS767 and WS780 fitted incorrectly and interchanged. Because of the decals' transposition, the Safety Board requested a U.S. operator to randomly inspect its 747 airplane aileron control systems for the aileron cable drum decal identification at WS767 and WS780. An inspection on November 24, 1997, of one 747-251, S/N 21707, production line number 378, revealed similar decal transposition on the right WS767 and WS780.

According to Boeing, if these decals are interchanged during installation, the transposition results in incorrect cable routing information at the aileron cable drum and may lead to incorrect cable positioning during installation. A review of the applicable engineering drawings shows that instructions for the decal installations are correct. A check of undelivered 747s at the Boeing factory (production line number 1130 and onward) revealed correct decal installations.

A BASI record review identified eight airplanes from various operators that have had aileron cable installation decals incorrectly installed. Boeing issued Service Letter 747-SL-27-98-

[1] Aileron control system decals are affixed to the airplane in strategic locations to provide illustrative and textual information about the type and routing of cables.

A on May 6, 1991, which addresses the incorrect installation of aileron control cable decals at WS1336.97, and suggests that the operators ensure the cables are properly installed per the applicable drawing. Boeing informed the Safety Board that it is planning to release a service bulletin (SB) to recommend that operators of 747s, produced before production line number 1130, check their airplanes for (1) correct routing of aileron control cables on the aileron cable drum located at WS776.98; and (2) correct installation, and replacement as required, of aileron cable decals at WS767 and WS780.

Boeing's February 8, 1996, In-Service Activities Report 96-02-2711-10 (747) details cable wear occurrences to three other airplanes and attributes the cable wear to misrouting of the cables at the aileron cable drum. Each of the three airplanes had accumulated 40,000-50,000 flight hours and 10,700-11,000 cycles. In each case, the cable appeared to have been chafing on the forward-most guide pin of the aileron cable drum as a result of cable misrouting. The data available regarding these incidents provides no information about whether the installation decals were properly located.

The BASI investigation concluded that the Brisbane incident was caused by misrouting of cables on the aileron cable drum at WS776.98 and that transposition of the aileron control cable decals on the aileron cable drum at WS767 and WS780 has the potential to cause misalignment of the aileron control cables during installation. The Safety Board is concerned that airplanes with mispositioned aileron cable installation decals may be susceptible to aileron cable failures in flight, which could jeopardize flight safety. The Safety Board believes that the Federal Aviation Administration should issue an airworthiness directive to require operators of 747s, produced before production line number 1130, to conduct a one-time inspection of the aileron control system to ensure correct routing of aileron control cables on the aileron cable drum located at WS776.98 and correct installation of aileron cable decals at WS767 and WS780 at the earliest possible inspection interval.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Issue an airworthiness directive to require operators of Boeing 747 airplanes, produced before production line number 1130, to conduct a one-time inspection of the aileron control system to ensure correct routing of the aileron control cables on the aileron cable drum located at wing station (WS)776.98 and correct installation of aileron cable decals at WS767 and WS780 at the earliest possible inspection interval. (A-98-6)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 9, 1998
In reply refer to: A-98-7

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On September 8, 1996, a United Airlines Boeing 737-322, N332UA, experienced what the flightcrew described as severe airframe vibration accompanied by feedback through the rudder pedals after departure from Newark International Airport, Newark, New Jersey. The pilots indicated to the air traffic controller that they would return to the airport and then landed without incident.

While investigating this occurrence, the National Transportation Safety Board was informed of a previous event that had occurred on August 6, 1993. In this event, a United Airlines Boeing 737-300, N340UA, which had departed from LaGuardia Airport, Flushing, New York, encountered intermittent high amplitude vibration in the rudder pedals. The flight diverted to Newark, New Jersey, where it landed without incident.

According to United Airlines, after the first event, N340UA was placed on jacks to simulate the flight mode. It was noted that application of the main wheel brakes caused a kickback or vibration in the rudder pedals. This vibration subsided when either the antiskid system or the "B" system hydraulics were turned off. Also, United Airlines issued an operational alert bulletin to its flightcrews that described the event. United Airlines has attributed the rudder pedal vibrations on both the August 6, 1993, and September 8, 1996, incidents to inadvertent activation by the pilot of the main wheel brakes while in flight.

According to the Boeing Commercial Airplane Group, the antiskid system prevents skidded or blown tires on landing should the pilot inadvertently apply the brakes before touchdown. In the air mode, instability in the brake pedals can occur when the pedals are rapidly depressed, and results in an oscillation of the brake pedals and the rudder.

This condition affects the B-737-300, 737-400, and 737-500 series airplanes. Discussions with Boeing revealed that although the Boeing 737 operations manual states, "...Do not apply brakes after becoming airborne. Braking is automatically applied when the Landing Gear Lever is placed in the UP position...," there is no warning or mention of the possibility of rudder and

rudder pedal vibration in the FAA-approved airplane flight manual.[1] In addition, the operations manual does not mention the consequences of applying the brakes in flight or any corrective action necessary to stop rudder pedal vibration that could result from that action. The Safety Board is concerned that as long as this condition exists, it should be appropriately annotated in the FAA-approved airplane flight manual, along with the appropriate corrective actions defined. Therefore, the Safety Board believes that the FAA should require Boeing to make an addition to the FAA-approved airplane flight manual and abnormal procedures to state that severe vibration of the rudder and rudder pedals may be experienced if the main wheel brakes are applied while airborne and to describe corrective action necessary to terminate the vibration, for Boeing 737 airplanes that are subject to braking system vibrations from airborne brake application.

Therefore, the National Transportation Safety Board recommends the following to the Federal Aviation Administration:

> Require the Boeing Commercial Airplane Group to make an addition to the FAA-approved airplane flight manual and abnormal procedures to state that severe vibration of the rudder and rudder pedals may be experienced if the main wheel brakes are applied while airborne and to describe corrective action necessary to terminate the vibration, for Boeing 737 airplanes that are subject to braking system vibrations from airborne brake application. (A-98-7)

Chairman HALL and Members HAMMERSCHMIDT and BLACK concurred in this recommendation. Vice Chairman FRANCIS and Member GOGLIA did not concur.

By: Jim Hall
Chairman

[1] On some other airplanes it is common practice to apply the brakes shortly after takeoff to stop the main landing gear wheels from spinning in the wheel wells after gear retraction. This action prevents wheel vibration as the wheels spin down to a stop.

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

CORRECTED COPY

Date February 13, 1998
In reply refer to: A-98-8

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On April 23, 1996, a Delta Air Lines McDonnell Douglas MD-88 airplane, N985DL, operating as flight 1593, experienced an uncontained low pressure turbine (LPT) failure[1] in the No. 2 (right) engine during a regularly scheduled Title 14 Code of Federal Regulations (CFR) Part 121 passenger flight from Washington, D.C., to Atlanta, Georgia. The flightcrew reported that while cruising at flight level (FL) 310, they heard a "loud bang" from the No. 2 engine, a Pratt & Whitney (P&W) JT8D-219, serial number (SN) 725978. The engine lost power, followed by a loss of oil pressure and quantity. The pilot shut down the engine, declared an emergency, and diverted to the Raleigh-Durham International Airport without further incident.

Inspection of the aircraft revealed a 3-foot by 1-foot hole in the upper cowling of the No. 2 engine nacelle with no other noted aircraft damage. Examination of the engine revealed that the bolts securing the rear turbine case rear flange to the turbine exhaust case (TEC) front flange had fractured, allowing the two flanges to separate, creating an opening approximately 1-inch wide. Considerable impact damage was observed on the inner diameter of both cases; however, neither case was penetrated. The 4th stage blades exited the engine through the opening between the cases before damaging the engine cowling.

Examination of the LPT revealed that all the 4th stage turbine blades, part number (PN) 798404, were fractured transversely across the airfoil just above the blade root platform, and that the blade roots were retained in the disk. Metallurgical examination of one blade root revealed high cycle fatigue (HCF)[2] that initiated on the convex airfoil side and propagated from 75 to 80 percent through the airfoil before failing in overload. No defects were observed in the fracture

[1] This is the only documented case of an uncontained low pressure turbine blade event occurring in a JT8D-200 engine.

[2] HCF is the mechanism in which cracks propagate an incremental amount from the bending stresses associated with resonant frequency vibration. The vibration can cause rapid crack progression through a component. The failure can occur under normal operational stress after the crack progresses through sufficient cross section of the component.

origin area. Examination of the 4th stage LPT blade shroud notches[3] that were recovered from the exhaust case revealed evidence of extreme notch wear estimated at 0.030 to 0.050 inch in depth.

In response to reports of numerous rear turbine case/TEC attachment bolts fracturing during LPT blade fracture events, P&W issued Service Bulletin (SB) 6149 on January 19, 1994, to provide bolts made of a stronger material. The original bolts, made of Tinidur, a steel alloy, lacked the strength needed to prevent the flanges from separating during an LPT blade failure. The stronger bolt, made of Inconel 718, a nickel alloy, improves the containment capability of the flange. Tinidur bolts were involved in this event.

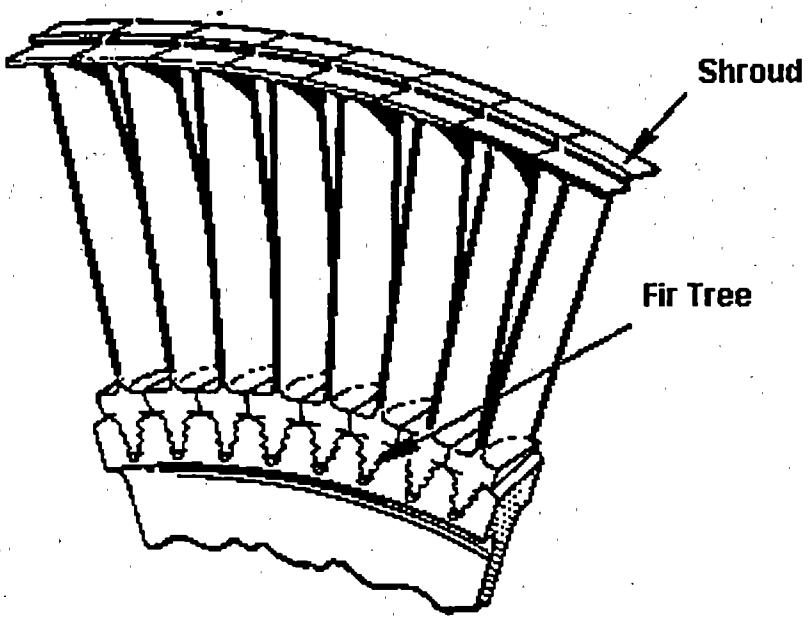
Two days after this event, on April 25, 1996, another Delta Air Lines, McDonnell Douglas MD-88 airplane, N959DL, operating as flight 591, experienced a contained No. 1 (left) engine LPT failure while climbing from FL 310 to FL 330. The flightcrew reported hearing a "loud bang" from the No. 1 engine, a P&W JT8D-219, SN 725977. The pilot shut down the engine and diverted to Shreveport, Louisiana, where the landing was uneventful and no injuries occurred.

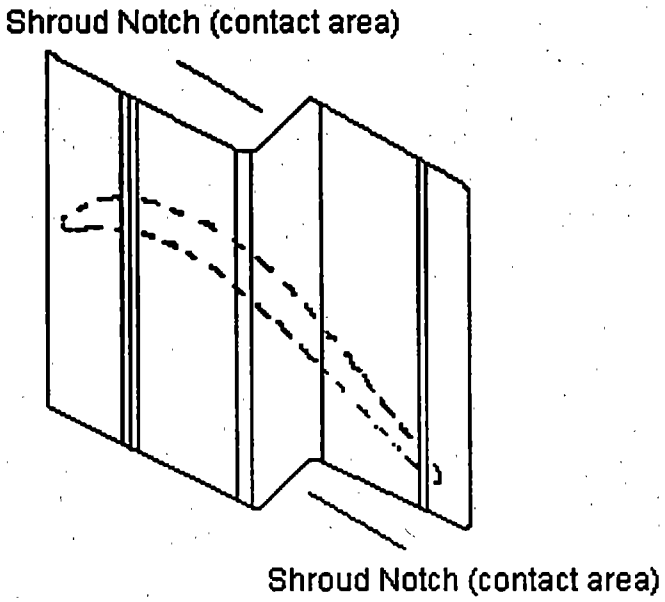
Examination of the LPT revealed that all of the 3rd and 4th stage turbine blades were fractured transversely across the airfoil just above the blade root platform. As in the first incident, metallurgical examination of a 4th stage LPT blade, PN 798404, revealed HCF cracking that originated on the airfoil convex side. No defects were noted at the fatigue origin. No evidence of fatigue was observed on the 3rd stage LPT blades, nor were any 3rd or 4th stage blade shrouds recovered to determine the extent of the shroud notch wear.

Along with the HCF on the 4th stage LPT blades, there were other similarities to indicate a connection between the two events and possible causes. The engine serial numbers were consecutive (725977 and 725978); both engines had approximately the same number of cycles (10,833 and 10,862) at the time of failure; both LPT modules were essentially in the same condition as when they were delivered from P&W, with no repairs performed to the internal components; and both 4th stage LPT blades were PN 789404, which has a thin shroud notch configuration.

The JT8D LPT blade design incorporates a blade tip shroud for structural support and vibration dampening. The blade shrouds interlock to provide stiffness so that they function as a single ring to reduce blade flexing caused by thermal, aerodynamic and centrifugal loads. The shroud notches (contact areas) are coated with PWA 694, which is a cobalt alloy that is a hard temperature and wear resistant material, to help reduce wearing. Worn shroud notch surfaces reduce blade damping and drop the blades' resonance frequency into the engine operating range. This increases the vibratory stresses to levels that can initiate fatigue cracking.

[3] The blade is a casting. The shroud is an integral part of the blade and it is located outboard on the airfoil.





Typical Top View of Blade

According to P&W, the JT8D-200 series engine has experienced 180 3rd and 4th stage LPT blade failures resulting from two different failure modes. The first is excessively worn LPT blade notches that can result in HCF fractures occurring at the root of the 3rd and 4th stage blades. P&W indicated that approximately 95 percent of all 3rd and 4th stage blade failures are the result of

worn shroud notches. The second is a low cycle fatigue (LCF)[4] crack initiating in the 4th stage blade shroud fillet resulting in a cross-notch failure.

P&W addressed the wear problem by increasing the blade's shroud notch contact area. The objective was to reduce the notch wear rate and thereby reduce blade failures. Three SBs were issued to introduce new 3rd and 4th stage LPT blade designs. SB 5867[5] was issued on September 22, 1989, to replace the 3rd stage thin shroud notch blade configuration with a blade featuring an increased contact area. There have been only two documented 3rd stage LPT blade failures of this new blade. SBs 6029[6] and 6090[7] were issued on June 18, 1991, and August 6, 1992, respectively, to introduce 4th stage blades with a similar larger contact area. There have been 18 recorded blade failures since the introduction of the two new blades. At a briefing conducted for the FAA and the Safety Board on October 11, 1997, P&W stated that the increased failure rate is due to the addition of more shroud material used for the thick notch. This extra material increased the LCF stresses in the shroud fillet radius resulting in thick notch shroud failures. The blade design was upgraded to reduce the fillet radius stresses so that the shrouds would no longer fracture, but kept the thick notch configuration to address the fractures due to excessive notch wear. P&W issued SB JT8D-6308 on October 10, 1997, to introduce this upgraded 4th stage LPT blade and made it available to the operators in early November 1997. Thus far, there is not yet any operational experience with this current design.

On March 7, 1996, an American Airlines McDonnell Douglas MD-82 airplane, N73444, operating as flight 1853, experienced a contained No. 2 engine failure en route to Orlando, Florida. The flightcrew reported hearing a "loud bang" and experienced a subsequent loss of power in the No. 2 engine, a P&W JT8D-217C, SN 718479. The airplane returned to Chicago, Illinois, without further incident. Engine disassembly revealed that all of the 3rd and 4th stage LPT blades were fractured near the airfoil root. The engine was equipped with the 4th stage LPT blade, PN 808904, that was introduced by SB 6090. The increased blade shroud notch surface on this blade was designed to have eliminated the HCF fractures at the blade root platform that occurred in this event.

From 1973 through 1989, there were 527[8] documented cases of 3rd and 4th stage LPT blade HCF fractures occurring in JT8D-1 through -17AR series engines.[9] The LPT blade failures

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[4] LCF is the mechanism in which cracks propagate an incremental amount from the increased pressure, temperature, and centrifugal stresses associated with starting an engine and increasing the thrust to takeoff power.

[5] SB 5867 replaced blade PN 772203 with PN 804303. The change is applicable to -209, -217 and -217A series. There have been 88 documented LPT blade, PN 772203, fractures. This accounted for 85 percent of all 3rd stage -200 blade failures. Approximately 65 percent of the current -200 series engine fleet has PN 804303 blades installed.

[6] SB 6029 replaced blade PN 775404 with PN 804304. The change is applicable to -209, -217 and -217A series. There have been 32 documented LPT blade, PN 775404, fractures. This accounted for 31 percent of all 4th stage -200 series blade failures. Approximately 72 percent of the current -200 series engine fleet has PN 804304 blades installed.

[7] SB 6090 replaced or modified PNs 798404 and 810504 with PN 808904. The change is applicable to -217C and -219 series engines. There have been 27 documented LPT blade, PN 798404, fractures. This accounted for 26 percent of all the 4th stage -200 series blade failures. Approximately 75 percent of the current -200 series engine fleet has PN 808904 blades installed.

[8] This is the number of documented blade failures at the time of the issuance of ASB A5913 on April 2, 1990.

were caused by excessively worn shrouds resulting in 21 uncontained turbine events. To manage the problem, P&W issued an alert service bulletin (ASB), A5913, on April 2, 1990, to perform recurrent inspections for wear on the blade notches for installed 3rd and 4th stage LPT blades. The FAA mandated this action with the issuance of Airworthiness Directives (AD) 94-20-08 and 94-20-09, on November 14, 1994. The inspection uses a mechanical tool made up of a torque screwdriver and notch gauge. The tool is inserted through the exhaust duct and placed between two adjacent 3rd or 4th stage LPT blades. The tool is then rotated to separate the blades, and the amount of torque to do so is recorded. This gives an indication of the amount of wear present on the blade notches. Blades that have worn shrouds require less torque to separate and vice versa. Analysis of the torque check data indicated that the inspection was effective in identifying worn notches before blade failures in JT8D-1 through -17AR series engines.

P&W determined that the same failure mechanism that had occurred in the JT8D-1 through -17AR series was also occurring in the -200 series. Based on the success of the torque check on -1 through -17AR series engines, P&W issued SB 6224 on October 12, 1995, to address the -200 series engines just as ASB A5913 had for the -1 through -17AR series. However, because of differences in blade geometry and operating environment for the -200 series engines, the inspection interval and torque limits were varied. The notch gauges were redesigned, and the number of inspection locations within the 3rd and 4th stage LPT were modified. P&W recommended that the time intervals listed in SB 6224 not be considered hard requirements because the times were based on limited service data and those operators, who had established inspection intervals based on their own experience, are continuing to use their own criteria until operational data results in revised limits. Thus far, there is no information available from the operators that verifies whether the torque check on the -200 series is effective and the proposed inspection interval is appropriate.

Several operators, including American Airlines, Trans World Airlines and Continental Airlines, are using an isotope inspection (x-ray) to determine the amount of wear on the blade shrouds, instead of the torque check. From the x-ray, the blade offset and shroud gap are measured to determine the notch wear. P&W is currently reviewing this technique and the operators' proposed limits, and is collecting data to determine the inspection's effectiveness. Other operators are using shims to measure the gap between blades and to define acceptable wear limits. Each of the techniques mentioned may be effective, but the torque check remains the only P&W-approved procedure for determining the amount of blade notch wear. The lack of operational data on any of these inspection techniques makes determining the appropriate method(s) for measuring the wear difficult.

Worn LPT blade shrouds can result in blade failures causing considerable engine and aircraft damage on JT8D-200 series engines even with the incorporation of the redesigned blades with the thicker shroud notch. The Safety Board concludes that recurrent inspection of the 3rd and 4th stage LPT blades for notch wear is needed to prevent future failures. Therefore, the Safety Board believes that the FAA should determine the effectiveness of inspection techniques used to measure the amount of shroud wear on installed 3rd and 4th stage low pressure turbine

[9] Of the 527 LPT events, 456 were 3rd stage and the remaining 71 were 4th stage. Thirteen of the uncontained events were 3rd stage LPT failures with the remaining 8 4th stage.

blades on P&W JT8D-200 series turbofan engines, and mandate inspection techniques determined to be most effective based on an interval derived from failure and operational data.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Determine the effectiveness of inspection techniques used to measure the amount of shroud wear on installed 3rd and 4th stage low pressure turbine blades on Pratt & Whitney JT8D-200 series turbofan engines, and mandate inspection techniques determined to be most effective based on an interval derived from failure and operational data. (A-98-8)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 26, 1998
In reply refer to: A-98-24

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On November 24, 1996, the flightcrew of Northwest Airlines (NWA) flight 211, an Airbus A-320-211, N310NW, experienced stiff rudder pedals approximately 50 feet above the ground before landing at Detroit Metropolitan Airport, Michigan. The flight, which was operating under the provisions of Title 14 Code of Federal Regulations Part 121 as a regularly scheduled passenger flight from Ft. Lauderdale, Florida, to Detroit, landed without further incident. The 6 crewmembers and 141 passengers were not injured. Instrument meteorological conditions prevailed at the time of the incident.

The captain of the flight stated that he had disengaged the autopilot (A/P) approximately 15 miles from the airport and was flying a manual approach. No problems were observed with the rudder or yaw damper during this time. However, when the captain attempted to use the rudder to compensate for a crosswind just before landing, he discovered that the rudder pedals were "locked in the neutral position." The captain used aileron inputs to keep the airplane aligned with the runway centerline through the touchdown and differential braking to steer the airplane during the landing roll until he engaged nosewheel steering at 80 knots. After exiting the runway, the captain performed several A/P disconnects, with no change in the rudder pedal force. He and the first officer then made several attempts to free the rudder pedals. After manipulating the rudder for approximately 15 seconds, the rudder pedal movement returned to normal.

Following the incident, NWA maintenance personnel examined the rudder and A/P systems. No anomalies were observed and no evidence of water or ice was found on the rudder cable assemblies. The rudder A/P artificial feel and trim solenoid was removed and replaced, and the airplane was returned to service the day after the incident. Subsequent Safety Board analysis of the flight data recorder readout confirmed that the A/P was disengaged when the captain experienced stiff rudder pedals.

At the request of the Safety Board, the rudder artificial feel and trim unit from the airplane was tested at an Airbus laboratory under supervision of the French Bureau Enquete Accidents. Although the unit's solenoid functioned properly, excessive forces were required to rotate the unit's A/P-mode engagement/disengagement lever. This occurred during testing at ambient and cold temperatures (-40° F).

A review of the service history on the A-320 rudder system revealed Airbus Service Bulletin (SB) A320-27-1042, dated March 21, 1992, titled "Flight Controls - Rudder - Increase Radial Play of Lever Bearing in the Artificial Feel and Trim Unit." The SB was prompted by 10 incidents in which the artificial feel and trim unit did not disengage from the A/P mode (stiff pedal operation) and return to normal pedal operating forces during approach and landing. These failures were attributed to increased operating forces in the bearing of the A/P engagement/disengagement lever in the artificial feel and trim unit and may have been aggravated by exposure to cold temperatures. The SB introduced a modified lever with a larger radial play of the bearing to eliminate the problem. On April 30, 1997, Airbus sent a telex to A-320 operators citing two recent incidents involving stiff rudder pedals and strongly recommending that the SB action be incorporated. The Direction Generale De L'Aviation Civile, the French aviation authority, has not issued an airworthiness directive (AD) to require the SB modification (which is not mandatory).

The NWA A-320 involved in the November 24, 1996, incident had not been modified in accordance with the SB. Because an unexpected restriction of the rudder pedals could cause a loss of control during a critical phase of flight, the Safety Board believes that the Federal Aviation Administration should issue an AD to require the installation of a modified engagement/disengagement lever in the rudder artificial feel and trim unit on all Airbus A-320 airplanes, in accordance with Airbus SB A320-27-1042, to ensure that the correct operating force exists at the rudder pedals. Although the SB modification has been incorporated on most of the A-320 airplanes operating in the United States, America West has indicated that some of its airplanes have probably not been modified. Full fleet compliance is necessary to ensure that none of the remaining airplanes are affected by this known system problem. The Safety Board is also concerned that A-320 airplanes could enter into U.S. service in the future without the SB modification.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Issue an airworthiness directive to require the installation of a modified engagement/disengagement lever in the rudder artificial feel and trim unit on all Airbus A-320 airplanes, in accordance with Airbus Service Bulletin A320-27-1042, to ensure that the correct operating force exists at the rudder pedals. (A-98-24)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 25, 1998
In reply refer to: A-98-25 and -26

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On January 26, 1997, Northwest Airlines (NWA) flight 20, a Boeing 747-251, N627US, experienced an engine case rupture of its No. 1 Pratt & Whitney (P&W) JT9D-7Q engine during takeoff at Narita International Airport, Tokyo, Japan. During the takeoff roll, as engine power was set to approximately 1.58 engine pressure ratio and the airplane was rolling forward at low speed, a loud bang was heard by the flightcrew. The captain rejected the takeoff and returned to the gate without further incident; no injuries resulted. The crew reported that there were no fire warning or nacelle overheat indications. The airplane was operated under Title 14 Code of Federal Regulations Part 121, as a regularly scheduled passenger flight from Tokyo, Japan, to Minneapolis, Minnesota.

The No. 1 engine diffuser case ruptured and as a result, both engine side cowl doors, a precooler, and other hardware were ejected from the engine. The escaping gas and engine debris blew out the engine pylon access panels, and created holes, cracks, and other damage to the wing's leading edge, aileron, and flaps. Engine debris came to rest on the only runway at the airport, causing the airport to be closed for several hours.

The National Transportation Safety Board's (NTSB) examination of the engine discovered an L-shaped crack in the outer pressure wall in the rear skirt area of the diffuser case that was deflected outward exposing the bulged combustion chamber inside the engine. The crack extended fore and aft approximately 18 inches from the diffuser case's rear flange at the 11 o'clock[1] position. The crack turned 90° and extended circumferentially around approximately 120° of the case's circumference, in the counterclockwise direction. The crack passed adjacent to a 3-inch long, dog bone-shaped embossment (boss), located about 10 inches forward of the rear flange at the 11 o'clock position. The boss was the attachment point for the upper most mount bracket of the engine's 116-pound precooler.[2]

[1] All references to the clock are as viewed from aft looking forward.

[2] The precooler is an air-to-air heat exchanger that cools the engine bleed air from the high-pressure compressor (HPC) with cooler fan discharge (ram) air. Pressurized air from the HPC is regulated by 8th- and 15th-stage bleed air valves before entering the precooler. Ram air is regulated by two valves as it exits the precooler.

A section of the diffuser case rear skirt (see figure 1) was examined at the Safety Board's materials laboratory in Washington, D.C. Examination of the fracture surface, approximately 10 ½ inches from the rear flange, adjacent to the upper precooler mount boss, revealed a 5-inch long discolored high cycle fatigue[3] (HCF) zone with about 90,000 striations. The fatigue initiated at a crack that looked like two thumbnail-shaped, gray-colored areas, which were approximately 0.040-inch wide by 0.010-inch deep. High levels of delta phase precipitate[4] were discovered in the thumbnail-shaped origin areas. Individual 0.0005 to 0.0008-inch deep toolmarks or scratches were found on the outer case wall extending the length of the origin area. Numerous additional toolmarks were found on the exterior surface of the rear skirt. The toolmarks were formed when the exterior surface of the case was machined (blended) during manufacture. The diffuser case had accumulated 9,342 total flight cycles[5] since new.

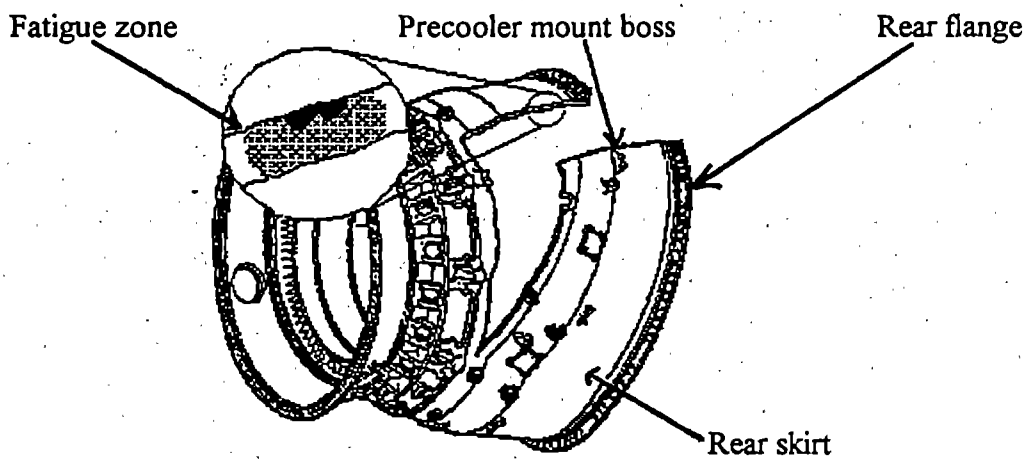

Figure 1: Ruptured diffuser case

A metallurgical analysis of the fracture surface indicated that the thumbnail-shaped cracks had initiated at the base of the toolmarks because of a combination of high residual stresses and low-cycle fatigue[6] (LCF). The crack then propagated in HCF, as evidenced by the very small striation spacing found in the majority of the 5-inch long fatigue zone, after which the crack progressed to failure in tensile overload.

Based on the morphology of the fracture, metallurgical tests were also conducted at P&W's Mechanics and Material Engineering laboratory, in East Hartford, Connecticut, to evaluate the case material's fatigue properties that were initiated by toolmarks. Specimens tested with toolmarks present were found to have one-fourth the predicted life of identical specimens tested without toolmarks.

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[3] HCF is a phenomenon in which a crack progresses an incremental amount (one striation) as a result of the cyclical stresses associated with vibration.

[4] The delta phase precipitate is a normally existing high temperature phase in INCONEL 718 and was most likely formed by the elevated temperatures associated with the heat treatment process of the diffuser case.

[5] A flight cycle is one takeoff and landing.

[6] LCF is a phenomenon in which a crack progresses an incremental amount (one striation) as a result of the cyclical stresses associated with rise and fall of the engine's internal pressure, temperature, or the revolutions per minute associated with each flight cycle.

Metallurgical examination of the precooler at the Safety Board's materials laboratory revealed HCF cracks at the attach points of two internal support rods. Seven other rods with identical HCF cracks were found to have been previously weld repaired. Wear marks and contact marks were also found on the engine bracket and support link of the precooler's upper attachment point. Additionally, a review of the maintenance records revealed that seven flight cycles before the diffuser case rupture, the engine had an in-flight shutdown (IFSD) because of a turbine cooling air (TCA) tube failure. The records revealed that during the inspection following the IFSD, the TCA tube mount clamp, which normally supports the tube at about mid-span, was discovered missing, and a station-4 static pressure sense line (Ps4) was also discovered to be fractured. The TCA tube and clamp, and the Ps4 line were replaced. The records also revealed that 260 flight cycles before the diffuser case rupture, a cracked lenticular seal[7] was discovered during disassembly of the high-pressure turbine.

The incident aircraft had no engine vibration monitoring (EVM) equipment. Although no EVM equipment was installed, the fractured diffuser case and Ps4 line, the missing TCA tube, the precooler cracks, and the precooler bracket wear suggest a vibratory environment. As a result, the Safety Board's investigation attempted to identify potentially vibratory resonant conditions or excitation sources within the engine. A vibration survey was performed at P&W on a normally operating JT9D-7R4 engine that had a similar diffuser case but no precooler. P&W also conducted finite element analyses of the JT9D-7Q's TCA tube installation and the precooler installation to determine the stresses from an assumed engine oscillatory force equivalent to 2.5 times the force of gravity, which is considered to be a high vibration level for this engine. Finally, P&W estimated the amount of vibratory excitation imparted to the engine because of a cracked lenticular seal.

The results of the vibration survey did not reveal any resonant conditions or excitation sources stemming from normal engine operation. The finite element analysis of the precooler installation revealed that the stresses from a high vibrating engine were not sufficient to initiate a crack in the case. Finally, the maximum levels of vibration from a cracked lenticular seal, or from a supported or unsupported resonating TCA tube, were not of sufficient magnitude to be excitation sources.

A review of the failure history of the JT9D-7Q since certification in 1978, revealed that this is the first diffuser case rupture originating in the rear skirt area. The JT9D-59A and -70, which have an interchangeable diffuser case with the JT9D-7Q, had two diffuser case rupture events early in their operation history; these originated in the front skirt area. Since the issuance of Airworthiness Directive 94-26-06, which requires inspection of the front skirt in the vicinity of the 15th-stage bleed air bosses, no additional ruptures have originated in the front skirt area.

The proximity of the crack origin to the precooler mount boss and the HCF crack propagation suggests that high precooler vibration imparted higher than normal loading into the precooler mount boss and the diffuser case. Additionally, the postincident fatigue tests of the case material indicates that high levels of vibration alone are insufficient to initiate a crack. The

[7] The lenticular seal is a torroid-shaped, steel seal clamped between the 1st-and 2nd-stage HPT disks that incorporates four knife edge seals around the outer diameter.

evidence also suggests that a tool mark or other defect in the case, combined with LCF, is required to initiate a crack and that high levels of vibration can propagate the crack.

As a result, P&W reports that it is drafting a service bulletin to propose a repair for toolmarks stemming from the blending of the diffuser case during manufacture. Additionally, Boeing reports that it is drafting a service letter that proposes a rework of the engine bracket to the precooler's upper attachment point on the JT9D-7Q installation to increase clearance between the bracket and support link to reduce vibration and to reduce wear.

Because it appears that preventative measures can obviate future diffuser case ruptures originating in the rear skirt area with minimal impact to airline operations, the Safety Board believes that the Federal Aviation Administration (FAA) should require a one-time visual inspection of the diffuser case rear skirt on P&W JT9D-7Q engines to locate scratches and tool marks when the diffuser case is next at the piece-part level, and blend repair as required to prevent tool marks and scratches from becoming crack initiation sites. The Safety Board also believes that the FAA should require modification of the engine bracket that attaches to the diffuser case's precooler upper mount boss on the P&W JT9D-7Q installation to increase clearance between the bracket and support link to reduce vibration and to reduce wear.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require a one-time visual inspection of the diffuser case rear skirt on Pratt & Whitney JT9D-7Q engines to locate scratches and tool marks when the diffuser case is next at the piece-part level, and blend repair as required to prevent tool marks and scratches from becoming crack initiation sites. (A-98-25)

Require modification of the engine bracket that attaches to the diffuser case's precooler upper mount boss on the Pratt & Whitney JT9D-7Q installation to increase clearance between the bracket and support link to reduce vibration and to reduce wear. (A-98-26)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 24, 1998

In reply refer to: H-98-1

Honorable Kenneth R. Wykle
Administrator
Federal Highway Administration
400 7th Street, SW
Washington, D.C. 20590

About 9:15 a.m. on June 11, 1997, a 1981 General Motors Corporation transit bus collided with seven pedestrians at a "park and ride" transit facility in Normandy, Missouri. The bus was being operated by a driver trainee who had just completed a routine stop at the station. After allowing the passengers to debark from the bus, the driver trainee began to move the bus forward to provide clearance for another bus to pass. The driver trainee, who was reportedly unable to stop the bus, allowed it to surmount the curb and continue onto the station platform. The resulting encroachment onto the platform resulted in the deaths of four pedestrians and injuries to three others.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the driver trainee's misapplication of the accelerator, resulting in the bus's over-ride of the curb and travel onto the occupied pedestrian platform. Contributing to the deaths and injuries was the absence of effective positive separation between the transit facility roadway and the station's pedestrian platform.

While investigating this accident, the Safety Board found that the accident's most significant element was not its cause but its severity. In many instances, a similar momentary error on the part of a busdriver might have had far less serious consequences — such as damage to the bus and other property, slight injuries, or both. In this case, however, four people died and two suffered serious injuries. The crucial variable was the presence of unprotected pedestrians in the bus's path. Therefore, the Safety Board considered whether and how the effects of the accident could have been mitigated.

[1]For more information, read Highway Accident Summary Report – *Bus Collision with Pedestrians, Normandy, Missouri, June 11, 1997* (NTSB/HAR-98/01/SUM).

The Bi-State Development Agency (BSDA) MetroLink line on which this accident occurred has a total of 18 stations, 4 of which are designed with saw-tooth bus parking bays similar to the accident location. A review of the BSDA's facility design requirements revealed that, during design development, attention was focused on avoiding conflicts and crossovers between buses and other vehicular traffic, as well as between buses and pedestrian traffic. The BSDA design specifications provided for, among other things, "standard saw-tooth bus bay" parking spaces and walkways to be paved and raised approximately 6 inches above the adjacent road surface.

No provisions were made for the construction of barricades or other devices to prevent vehicular traffic from entering areas of pedestrian congregation. The only barrier planned to be between the bus parking spaces and the pedestrian platforms was a raised 6-inch-high concrete curb. As a consequence of these design requirements and specifications, the facilities incorporating the saw-tooth parking bays were laid out in such a way that when buses pull into the parking spaces, their forward motion is directed toward areas where pedestrians tend to congregate.

According to the BSDA's deputy executive director and general manager of engineering and facilities management, the facility where the accident occurred was designed and built in accordance with guidelines common to the transit industry. The saw-tooth design is intended to facilitate station access by the passenger buses and minimize interference from pedestrian traffic. In 1981, the Urban Mass Transportation Administration (UMTA) publicized the design specifications for saw-tooth parking bays and illustrated their efficiency in providing parking for multiple buses. Additionally, the American Association of State Highway and Transportation Officials (AASHTO) guideline for park and ride facilities[2] states:

> ...where more than two buses are expected to be using a facility at one time, the saw-tooth arrangement is generally preferable, because it is easier for buses to bypass a waiting bus.

Although officials at neither the Federal Transit Administration nor the American Public Transit Association could estimate the percentage of stations using the saw-tooth configuration, the Safety Board is aware that station designs similar to the accident location have been used nationwide for many years. A consulting engineer employed by the BSDA told investigators that the design has been commonly used throughout his 40-year career.

While the Safety Board recognizes the efficiency of the saw-tooth station design for multiple bus parking, it is concerned that neither the design specifications followed by the BSDA nor the guidelines provided by UMTA or AASHTO include any type of positive separation that could prevent a defective or poorly driven bus from encroaching onto the pedestrian platform in normal (low-speed) operating conditions for parking lot facilities. A further selection from the AASHTO guideline for park and ride facilities states that:

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[2] AASHTO, *A Policy on Geometric Design of Highways and Streets*, 1994 edition.

> ...the area delineating the passenger refuge area should be curbed in order to reduce the height between the ground and the first bus step and reduce encroachment by buses on the passenger areas.

The Normandy station was designed in accordance with this guideline, which calls for a curb as the only separating device. The Safety Board considers that design guidelines should specify a positive separation barrier between the bus parking bay and the pedestrian platform sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. The circumstances of the Normandy accident clearly illustrate that the curb-only separation cannot contain the forward movement of a large bus. Consequently, the Safety Board concluded that the current design guidelines for saw-tooth parking bay configurations commonly followed by the transit industry fail to provide adequate pedestrian safety.

Following this accident, the BSDA took immediate action to address the safety problem posed by inadequate protection between bus parking and pedestrian areas. The BSDA installed barriers at all its facilities with saw-tooth parking bay layouts. Bollards designed to prevent low-speed overruns have been placed at the forward ends of all saw-tooth bus parking spaces at each of the four stations with saw-tooth bus bays. Such bollards will be included in the designs of future BSDA stations. Safety Board investigators examined these bollard installations and found them adequate to have stopped the bus involved in this accident from reaching the pedestrian area. Therefore, the Safety Board concluded that, had the positive separation barriers now installed at the Normandy station been in place at the time of the accident, the collision with the pedestrians would not have occurred.

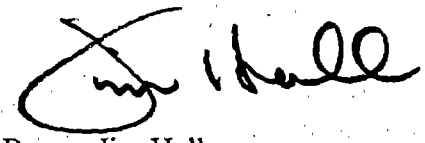
Therefore, the National Transportation Safety Board makes the following safety recommendation to the Federal Highway Administration:

> Ensure, in cooperation with the Federal Transit Administration, the American Association of State Highway and Transportation Officials, the American Public Transit Association, and the Community Transportation Association of America, that future transit facility designs incorporating "saw-tooth" bus parking bays, or other types of designs that direct errant vehicular traffic toward pedestrian-occupied areas, include provisions for positive separation between the roadway and pedestrian areas sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. (H-98-1)

The Safety Board also issued Safety Recommendations H-98-2 to the Federal Transit Administration, H-98-3 to the American Association of State Highway and Transportation Officials, H-98-4 and -5 to the American Public Transit Association, and H-98-6 and -7 to the Community Transportation Association of America.

Please refer to Safety Recommendation H-98-1 in your reply. If you need additional information, you may call (817) 652-7843.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.



By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 24, 1998

In reply refer to: H-98-2

Honorable Gordon J. Linton
Administrator
Federal Transit Administration
400 7th Street, SW
Washington, D.C. 20590

About 9:15 a.m. on June 11, 1997, a 1981 General Motors Corporation transit bus collided with seven pedestrians at a "park and ride" transit facility in Normandy, Missouri. The bus was being operated by a driver trainee who had just completed a routine stop at the station. After allowing the passengers to debark from the bus, the driver trainee began to move the bus forward to provide clearance for another bus to pass. The driver trainee, who was reportedly unable to stop the bus, allowed it to surmount the curb and continue onto the station platform. The resulting encroachment onto the platform resulted in the deaths of four pedestrians and injuries to three others.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the driver trainee's misapplication of the accelerator, resulting in the bus's over-ride of the curb and travel onto the occupied pedestrian platform. Contributing to the deaths and injuries was the absence of effective positive separation between the transit facility roadway and the station's pedestrian platform.

While investigating this accident, the Safety Board found that the accident's most significant element was not its cause but its severity. In many instances, a similar momentary error on the part of a busdriver might have had far less serious consequences — such as damage to the bus and other property, slight injuries, or both. In this case, however, four people died and two suffered serious injuries. The crucial variable was the presence of unprotected pedestrians in the bus's path. Therefore, the Safety Board considered whether and how the effects of the accident could have been mitigated.

[1]For more information, read Highway Accident Summary Report – *Bus Collision with Pedestrians, Normandy, Missouri, June 11, 1997* (NTSB/HAR-98/01/SUM).

The Bi-State Development Agency (BSDA) MetroLink line on which this accident occurred has a total of 18 stations, 4 of which are designed with saw-tooth bus parking bays similar to the accident location. A review of the BSDA's facility design requirements revealed that, during design development, attention was focused on avoiding conflicts and crossovers between buses and other vehicular traffic, as well as between buses and pedestrian traffic. The BSDA design specifications provided for, among other things, "standard saw-tooth bus bay" parking spaces and walkways to be paved and raised approximately 6 inches above the adjacent road surface.

No provisions were made for the construction of barricades or other devices to prevent vehicular traffic from entering areas of pedestrian congregation. The only barrier planned to be between the bus parking spaces and the pedestrian platforms was a raised 6-inch-high concrete curb. As a consequence of these design requirements and specifications, the facilities incorporating the saw-tooth parking bays were laid out in such a way that when buses pull into the parking spaces, their forward motion is directed toward areas where pedestrians tend to congregate.

According to the BSDA's deputy executive director and general manager of engineering and facilities management, the facility where the accident occurred was designed and built in accordance with guidelines common to the transit industry. The saw-tooth design is intended to facilitate station access by the passenger buses and minimize interference from pedestrian traffic. In 1981, the Urban Mass Transportation Administration (UMTA) publicized the design specifications for saw-tooth parking bays and illustrated their efficiency in providing parking for multiple buses. Additionally, the American Association of State Highway and Transportation Officials (AASHTO) guideline for park and ride facilities[2] states:

> ...where more than two buses are expected to be using a facility at one time, the saw-tooth arrangement is generally preferable, because it is easier for buses to bypass a waiting bus.

Although officials at neither the FTA nor the American Public Transit Association could estimate the percentage of stations using the saw-tooth configuration, the Safety Board is aware that station designs similar to the accident location have been used nationwide for many years. A consulting engineer employed by the BSDA told investigators that the design has been commonly used throughout his 40-year career.

While the Safety Board recognizes the efficiency of the saw-tooth station design for multiple bus parking, it is concerned that neither the design specifications followed by the BSDA nor the guidelines provided by UMTA or AASHTO include any type of positive separation that could prevent a defective or poorly driven bus from encroaching onto the pedestrian platform in normal (low-speed) operating conditions for parking lot facilities. A further selection from the AASHTO guideline for park and ride facilities states that:

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[2] AASHTO, *A Policy on Geometric Design of Highways and Streets*, 1994 edition.

> ...the area delineating the passenger refuge area should be curbed in order to reduce the height between the ground and the first bus step and reduce encroachment by buses on the passenger areas.

The Normandy station was designed in accordance with this guideline, which calls for a curb as the only separating device. The Safety Board considers that design guidelines should specify a positive separation barrier between the bus parking bay and the pedestrian platform sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. The circumstances of the Normandy accident clearly illustrate that the curb-only separation cannot contain the forward movement of a large bus. Consequently, the Safety Board concluded that the current design guidelines for saw-tooth parking bay configurations commonly followed by the transit industry fail to provide adequate pedestrian safety.

Following this accident, the BSDA took immediate action to address the safety problem posed by inadequate protection between bus parking and pedestrian areas. The BSDA installed barriers at all its facilities with saw-tooth parking bay layouts. Bollards designed to prevent low-speed overruns have been placed at the forward ends of all saw-tooth bus parking spaces at each of the four stations with saw-tooth bus bays. Such bollards will be included in the designs of future BSDA stations. Safety Board investigators examined these bollard installations and found them adequate to have stopped the bus involved in this accident from reaching the pedestrian area. Therefore, the Safety Board concluded that, had the positive separation barriers now installed at the Normandy station been in place at the time of the accident, the collision with the pedestrians would not have occurred.

Therefore, the National Transportation Safety Board makes the following safety recommendation to the Federal Transit Administration:

> Ensure, in cooperation with the Federal Highway Administration, the American Association of State Highway and Transportation Officials, the American Public Transit Association, and the Community Transportation Association of America, that future transit facility designs incorporating "saw-tooth" bus parking bays, or other types of designs that direct errant vehicular traffic toward pedestrian-occupied areas, include provisions for positive separation between the roadway and pedestrian areas sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. (H-98-2)

The Safety Board also issued Safety Recommendations H-98-1 to the Federal Highway Administration, H-98-3 to the American Association of State Highway and Transportation Officials, H-98-4 and -5 to the American Public Transit Association, and H-98-6 and -7 to the Community Transportation Association of America.

Please refer to Safety Recommendation H-98-2 in your reply. If you need additional information, you may call (817) 652-7843.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 24, 1998

In reply refer to: H-98-3

Mr. Francis B. Francois
Executive Director
American Association of State Highway and
Transportation Officials
444 North Capitol Street, NW
Suite 249
Washington, D.C. 20001

About 9:15 a.m. on June 11, 1997, a 1981 General Motors Corporation transit bus collided with seven pedestrians at a "park and ride" transit facility in Normandy, Missouri. The bus was being operated by a driver trainee who had just completed a routine stop at the station. After allowing the passengers to debark from the bus, the driver trainee began to move the bus forward to provide clearance for another bus to pass. The driver trainee, who was reportedly unable to stop the bus, allowed it to surmount the curb and continue onto the station platform. The resulting encroachment onto the platform resulted in the deaths of four pedestrians and injuries to three others.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the driver trainee's misapplication of the accelerator, resulting in the bus's over-ride of the curb and travel onto the occupied pedestrian platform. Contributing to the deaths and injuries was the absence of effective positive separation between the transit facility roadway and the station's pedestrian platform.

While investigating this accident, the Safety Board found that the accident's most significant element was not its cause but its severity. In many instances, a similar momentary error on the part of a busdriver might have had far less serious consequences — such as damage to the bus and other property, slight injuries, or both. In this case, however, four people died and two suffered serious injuries. The crucial variable was the presence of unprotected pedestrians in

[1]For more information, read Highway Accident Summary Report – *Bus Collision with Pedestrians, Normandy, Missouri, June 11, 1997* (NTSB/HAR-98/01/SUM).

the bus's path. Therefore, the Safety Board considered whether and how the effects of the accident could have been mitigated.

The Bi-State Development Agency (BSDA) MetroLink line on which this accident occurred has a total of 18 stations, 4 of which are designed with saw-tooth bus parking bays similar to the accident location. A review of the BSDA's facility design requirements revealed that, during design development, attention was focused on avoiding conflicts and crossovers between buses and other vehicular traffic, as well as between buses and pedestrian traffic. The BSDA design specifications provided for, among other things, "standard saw-tooth bus bay" parking spaces and walkways to be paved and raised approximately 6 inches above the adjacent road surface.

No provisions were made for the construction of barricades or other devices to prevent vehicular traffic from entering areas of pedestrian congregation. The only barrier planned to be between the bus parking spaces and the pedestrian platforms was a raised 6-inch-high concrete curb. As a consequence of these design requirements and specifications, the facilities incorporating the saw-tooth parking bays were laid out in such a way that when buses pull into the parking spaces, their forward motion is directed toward areas where pedestrians tend to congregate.

According to the BSDA's deputy executive director and general manager of engineering and facilities management, the facility where the accident occurred was designed and built in accordance with guidelines common to the transit industry. The saw-tooth design is intended to facilitate station access by the passenger buses and minimize interference from pedestrian traffic. In 1981, the Urban Mass Transportation Administration (UMTA) publicized the design specifications for saw-tooth parking bays and illustrated their efficiency in providing parking for multiple buses. Additionally, the AASHTO guideline for park and ride facilities[2] states:

> ...where more than two buses are expected to be using a facility at one time, the saw-tooth arrangement is generally preferable, because it is easier for buses to bypass a waiting bus.

Although officials at neither the Federal Transit Administration nor the American Public Transit Association could estimate the percentage of stations using the saw-tooth configuration, the Safety Board is aware that station designs similar to the accident location have been used nationwide for many years. A consulting engineer employed by the BSDA told investigators that the design has been commonly used throughout his 40-year career.

While the Safety Board recognizes the efficiency of the saw-tooth station design for multiple bus parking, it is concerned that neither the design specifications followed by the BSDA nor the guidelines provided by UMTA or AASHTO include any type of positive separation that could prevent a defective or poorly driven bus from encroaching onto the pedestrian platform in

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[2]AASHTO, *A Policy on Geometric Design of Highways and Streets*, 1994 edition.

normal (low-speed) operating conditions for parking lot facilities. A further selection from the AASHTO guideline for park and ride facilities states that:

> ...the area delineating the passenger refuge area should be curbed in order to reduce the height between the ground and the first bus step and reduce encroachment by buses on the passenger areas.

The Normandy station was designed in accordance with this guideline, which calls for a curb as the only separating device. The Safety Board considers that design guidelines should specify a positive separation barrier between the bus parking bay and the pedestrian platform sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. The circumstances of the Normandy accident clearly illustrate that the curb-only separation cannot contain the forward movement of a large bus. Consequently, the Safety Board concluded that the current design guidelines for saw-tooth parking bay configurations commonly followed by the transit industry fail to provide adequate pedestrian safety.

Following this accident, the BSDA took immediate action to address the safety problem posed by inadequate protection between bus parking and pedestrian areas. The BSDA installed barriers at all its facilities with saw-tooth parking bay layouts. Bollards designed to prevent low-speed overruns have been placed at the forward ends of all saw-tooth bus parking spaces at each of the four stations with saw-tooth bus bays. Such bollards will be included in the designs of future BSDA stations. Safety Board investigators examined these bollard installations and found them adequate to have stopped the bus involved in this accident from reaching the pedestrian area. Therefore, the Safety Board concluded that, had the positive separation barriers now installed at the Normandy station been in place at the time of the accident, the collision with the pedestrians would not have occurred.

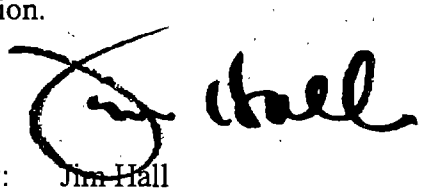
Therefore, the National Transportation Safety Board makes the following safety recommendation to the American Association of State Highway and Transportation Officials:

> Ensure, in cooperation with the Federal Highway Administration, the Federal Transit Administration, the American Public Transit Association, and the Community Transportation Association of America, that future transit facility designs incorporating "saw-tooth" bus parking bays, or other types of designs that direct errant vehicular traffic toward pedestrian-occupied areas, include provisions for positive separation between the roadway and pedestrian areas sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. (H-98-3)

The Safety Board also issued Safety Recommendations H-98-1 to the Federal Highway Administration, H-98-2 to the Federal Transit Administration, H-98-4 and -5 to the American Public Transit Association, and H-98-6 and -7 to the Community Transportation Association of America.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation H-98-3 in your reply. If you need additional information, you may call (817) 652-7843.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.



By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 24, 1998

In reply refer to: H-98-4 and -5

Mr. William Miller
President
American Public Transit Association
1201 New York Avenue, NW
Washington, D.C. 20005

About 9:15 a.m. on June 11, 1997, a 1981 General Motors Corporation transit bus collided with seven pedestrians at a "park and ride" transit facility in Normandy, Missouri. The bus was being operated by a driver trainee who had just completed a routine stop at the station. After allowing the passengers to debark from the bus, the driver trainee began to move the bus forward to provide clearance for another bus to pass. The driver trainee, who was reportedly unable to stop the bus, allowed it to surmount the curb and continue onto the station platform. The resulting encroachment onto the platform resulted in the deaths of four pedestrians and injuries to three others.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the driver trainee's misapplication of the accelerator, resulting in the bus's over-ride of the curb and travel onto the occupied pedestrian platform. Contributing to the deaths and injuries was the absence of effective positive separation between the transit facility roadway and the station's pedestrian platform.

While investigating this accident, the Safety Board found that the accident's most significant element was not its cause but its severity. In many instances, a similar momentary error on the part of a busdriver might have had far less serious consequences — such as damage to the bus and other property, slight injuries, or both. In this case, however, four people died and two suffered serious injuries. The crucial variable was the presence of unprotected pedestrians in the bus's path. Therefore, the Safety Board considered whether and how the effects of the accident could have been mitigated.

[1]For more information, read Highway Accident Summary Report – *Bus Collision with Pedestrians, Normandy, Missouri, June 11, 1997* (NTSB/HAR-98/01/SUM).

The Bi-State Development Agency (BSDA) MetroLink line on which this accident occurred has a total of 18 stations, 4 of which are designed with saw-tooth bus parking bays similar to the accident location. A review of the BSDA's facility design requirements revealed that, during design development, attention was focused on avoiding conflicts and crossovers between buses and other vehicular traffic, as well as between buses and pedestrian traffic. The BSDA design specifications provided for, among other things, "standard saw-tooth bus bay" parking spaces and walkways to be paved and raised approximately 6 inches above the adjacent road surface.

No provisions were made for the construction of barricades or other devices to prevent vehicular traffic from entering areas of pedestrian congregation. The only barrier planned to be between the bus parking spaces and the pedestrian platforms was a raised 6-inch-high concrete curb. As a consequence of these design requirements and specifications, the facilities incorporating the saw-tooth parking bays were laid out in such a way that when buses pull into the parking spaces, their forward motion is directed toward areas where pedestrians tend to congregate.

According to the BSDA's deputy executive director and general manager of engineering and facilities management, the facility where the accident occurred was designed and built in accordance with guidelines common to the transit industry. The saw-tooth design is intended to facilitate station access by the passenger buses and minimize interference from pedestrian traffic. In 1981, the Urban Mass Transportation Administration (UMTA) publicized the design specifications for saw-tooth parking bays and illustrated their efficiency in providing parking for multiple buses. Additionally, the American Association of State Highway and Transportation Officials (AASHTO) guideline for park and ride facilities[2] states:

> ...where more than two buses are expected to be using a facility at one time, the saw-tooth arrangement is generally preferable, because it is easier for buses to bypass a waiting bus.

Although officials at neither the Federal Transit Administration nor the APTA could estimate the percentage of stations using the saw-tooth configuration, the Safety Board is aware that station designs similar to the accident location have been used nationwide for many years. A consulting engineer employed by the BSDA told investigators that the design has been commonly used throughout his 40-year career.

While the Safety Board recognizes the efficiency of the saw-tooth station design for multiple bus parking, it is concerned that neither the design specifications followed by the BSDA nor the guidelines provided by UMTA or AASHTO include any type of positive separation that could prevent a defective or poorly driven bus from encroaching onto the pedestrian platform in normal (low-speed) operating conditions for parking lot facilities. A further selection from the AASHTO guideline for park and ride facilities states that:

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[2]AASHTO, *A Policy on Geometric Design of Highways and Streets*, 1994 edition.

> ...the area delineating the passenger refuge area should be curbed in order to reduce the height between the ground and the first bus step and reduce encroachment by buses on the passenger areas.

The Normandy station was designed in accordance with this guideline, which calls for a curb as the only separating device. The Safety Board considers that design guidelines should specify a positive separation barrier between the bus parking bay and the pedestrian platform sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. The circumstances of the Normandy accident clearly illustrate that the curb-only separation cannot contain the forward movement of a large bus. Consequently, the Safety Board concluded that the current design guidelines for saw-tooth parking bay configurations commonly followed by the transit industry fail to provide adequate pedestrian safety.

Following this accident, the BSDA took immediate action to address the safety problem posed by inadequate protection between bus parking and pedestrian areas. The BSDA installed barriers at all its facilities with saw-tooth parking bay layouts. Bollards designed to prevent low-speed overruns have been placed at the forward ends of all saw-tooth bus parking spaces at each of the four stations with saw-tooth bus bays. Such bollards will be included in the designs of future BSDA stations. Safety Board investigators examined these bollard installations and found them adequate to have stopped the bus involved in this accident from reaching the pedestrian area. Therefore, the Safety Board concluded that, had the positive separation barriers now installed at the Normandy station been in place at the time of the accident, the collision with the pedestrians would not have occurred.

Therefore, the National Transportation Safety Board makes the following safety recommendations to the American Public Transit Association:

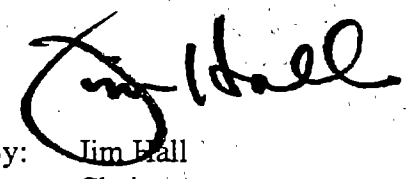
> Ensure, in cooperation with the Federal Highway Administration, the Federal Transit Administration, the American Association of State Highway and Transportation Officials, and the Community Transportation Association of America, that future transit facility designs incorporating "saw-tooth" bus parking bays, or other types of designs that direct errant vehicular traffic toward pedestrian-occupied areas, include provisions for positive separation between the roadway and pedestrian areas sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. (H-98-4)

> Notify your members of the circumstances of the Normandy, Missouri, accident of June 11, 1997, and encourage them to retrofit any existing facilities that incorporate saw-tooth bus parking bays or other types of designs that direct errant vehicular traffic toward pedestrian-occupied areas to include provisions for positive separation between the roadway and pedestrian areas sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. (H-98-5)

The Safety Board also issued Safety Recommendations H-98-1 to the Federal Highway Administration, H-98-2 to the Federal Transit Administration, H-98-3 to the American Association of State Highway and Transportation Officials, and H-98-6 and -7 to the Community Transportation Association of America.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations H-98-4 and -5 in your reply. If you need additional information, you may call (817) 652-7843.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.



By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 24, 1998

In reply refer to: H-98-6 and -7

Mr. Dale Marsico
Executive Director
Community Transportation Association of America
1341 G Street, NW
Suite 600
Washington, D.C. 20005

About 9:15 a.m. on June 11, 1997, a 1981 General Motors Corporation transit bus collided with seven pedestrians at a "park and ride" transit facility in Normandy, Missouri. The bus was being operated by a driver trainee who had just completed a routine stop at the station. After allowing the passengers to debark from the bus, the driver trainee began to move the bus forward to provide clearance for another bus to pass. The driver trainee, who was reportedly unable to stop the bus, allowed it to surmount the curb and continue onto the station platform. The resulting encroachment onto the platform resulted in the deaths of four pedestrians and injuries to three others.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the driver trainee's misapplication of the accelerator, resulting in the bus's over-ride of the curb and travel onto the occupied pedestrian platform. Contributing to the deaths and injuries was the absence of effective positive separation between the transit facility roadway and the station's pedestrian platform.

While investigating this accident, the Safety Board found that the accident's most significant element was not its cause but its severity. In many instances, a similar momentary error on the part of a busdriver might have had far less serious consequences — such as damage to the bus and other property, slight injuries, or both. In this case, however, four people died and two suffered serious injuries. The crucial variable was the presence of unprotected pedestrians in the bus's path. Therefore, the Safety Board considered whether and how the effects of the accident could have been mitigated.

[1]For more information, read Highway Accident Summary Report – *Bus Collision with Pedestrians, Normandy, Missouri, June 11, 1997* (NTSB/HAR-98/01/SUM).

The Bi-State Development Agency (BSDA) MetroLink line on which this accident occurred has a total of 18 stations, 4 of which are designed with saw-tooth bus parking bays similar to the accident location. A review of the BSDA's facility design requirements revealed that, during design development, attention was focused on avoiding conflicts and crossovers between buses and other vehicular traffic, as well as between buses and pedestrian traffic. The BSDA design specifications provided for, among other things, "standard saw-tooth bus bay" parking spaces and walkways to be paved and raised approximately 6 inches above the adjacent road surface.

No provisions were made for the construction of barricades or other devices to prevent vehicular traffic from entering areas of pedestrian congregation. The only barrier planned to be between the bus parking spaces and the pedestrian platforms was a raised 6-inch-high concrete curb. As a consequence of these design requirements and specifications, the facilities incorporating the saw-tooth parking bays were laid out in such a way that when buses pull into the parking spaces, their forward motion is directed toward areas where pedestrians tend to congregate.

According to the BSDA's deputy executive director and general manager of engineering and facilities management, the facility where the accident occurred was designed and built in accordance with guidelines common to the transit industry. The saw-tooth design is intended to facilitate station access by the passenger buses and minimize interference from pedestrian traffic. In 1981, the Urban Mass Transportation Administration (UMTA) publicized the design specifications for saw-tooth parking bays and illustrated their efficiency in providing parking for multiple buses. Additionally, the American Association of State Highway and Transportation Officials (AASHTO) guideline for park and ride facilities[2] states:

> ...where more than two buses are expected to be using a facility at one time, the saw-tooth arrangement is generally preferable, because it is easier for buses to bypass a waiting bus.

Although officials at neither the Federal Transit Administration nor the American Public Transit Association could estimate the percentage of stations using the saw-tooth configuration, the Safety Board is aware that station designs similar to the accident location have been used nationwide for many years. A consulting engineer employed by the BSDA told investigators that the design has been commonly used throughout his 40-year career.

While the Safety Board recognizes the efficiency of the saw-tooth station design for multiple bus parking, it is concerned that neither the design specifications followed by the BSDA nor the guidelines provided by UMTA or AASHTO include any type of positive separation that could prevent a defective or poorly driven bus from encroaching onto the pedestrian platform in normal (low-speed) operating conditions for parking lot facilities. A further selection from the AASHTO guideline for park and ride facilities states that:

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[2]AASHTO, *A Policy on Geometric Design of Highways and Streets*, 1994 edition.

> ...the area delineating the passenger refuge area should be curbed in order to reduce the height between the ground and the first bus step and reduce encroachment by buses on the passenger areas.

The Normandy station was designed in accordance with this guideline, which calls for a curb as the only separating device. The Safety Board considers that design guidelines should specify a positive separation barrier between the bus parking bay and the pedestrian platform sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. The circumstances of the Normandy accident clearly illustrate that the curb-only separation cannot contain the forward movement of a large bus. Consequently, the Safety Board concluded that the current design guidelines for saw-tooth parking bay configurations commonly followed by the transit industry fail to provide adequate pedestrian safety.

Following this accident, the BSDA took immediate action to address the safety problem posed by inadequate protection between bus parking and pedestrian areas. The BSDA installed barriers at all its facilities with saw-tooth parking bay layouts. Bollards designed to prevent low-speed overruns have been placed at the forward ends of all saw-tooth bus parking spaces at each of the four stations with saw-tooth bus bays. Such bollards will be included in the designs of future BSDA stations. Safety Board investigators examined these bollard installations and found them adequate to have stopped the bus involved in this accident from reaching the pedestrian area. Therefore, the Safety Board concluded that, had the positive separation barriers now installed at the Normandy station been in place at the time of the accident, the collision with the pedestrians would not have occurred.

Therefore, the National Transportation Safety Board makes the following safety recommendations to the Community Transportation Association of America:

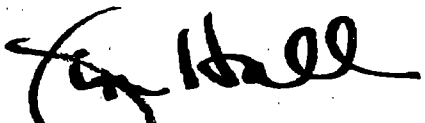
> Ensure, in cooperation with the Federal Highway Administration, the Federal Transit Administration, the American Association of State Highway and Transportation Officials, and the American Public Transit Association, that future transit facility designs incorporating "saw-tooth" bus parking bays, or other types of designs that direct errant vehicular traffic toward pedestrian-occupied areas, include provisions for positive separation between the roadway and pedestrian areas sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. (H-98-6)

> Notify your members of the circumstances of the Normandy, Missouri, accident of June 11, 1997, and encourage them to retrofit any existing facilities that incorporate saw-tooth bus parking bays or other types of designs that direct errant vehicular traffic toward pedestrian-occupied areas to include provisions for positive separation between the roadway and pedestrian areas sufficient to stop a bus operating under normal parking area speed conditions from progressing into the pedestrian area. (H-98-7)

The Safety Board also issued Safety Recommendations H-98-1 to the Federal Highway Administration, H-98-2 to the Federal Transit Administration, H-98-3 to the American Association of State Highway and Transportation Officials, and H-98-4 and -5 to the American Public Transit Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations H-98-6 and -7 in your reply. If you need additional information, you may call (817) 652-7843.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.



By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-1 through -4

Admiral Robert E. Kramek
Commandant
U.S. Coast Guard
Washington, D.C. 20593-0001

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the failure of Clearsky Shipping Company to adequately manage and oversee the maintenance of the engineering plant aboard the *Bright Field*, with the result that the vessel temporarily lost power while navigating a high-risk area of the Mississippi River. Contributing to the amount of property damage and the number and types of injuries sustained during the accident was the failure of the U.S. Coast Guard, the Board of Commissioners of the Port of New Orleans, and International RiverCenter, Inc., to adequately assess, manage, or mitigate the risks associated with locating unprotected commercial enterprises in areas vulnerable to vessel strikes.

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Board of Commissioners of the Port of New Orleans (the "Dock Board"), the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the Dock Board, had commissioned partial risk

[1] For more detailed information, read Marine Accident Report—*Allision of the Liberian Freighter* Bright Field *with the Poydras Street Wharf, Riverwalk Marketplace, and New Orleans Hilton Hotel in New Orleans, Louisiana, December 14, 1996.* (NTSB/MAR-98/01).

assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field*.

For example, risk assessment projects predicted an increase in accidents involving collisions, rammings, and groundings due to increased river traffic. The Louisiana State University risk assessment project, in 1994, concluded that no sections of the Port of New Orleans waterfront were free of ship allisions, including the area where the high-capacity passenger vessels, gaming vessels, and riverfront properties were located. Analysis of accident data for the Port of New Orleans from 1983 through 1993 (a total of 166 rammings along the left descending bank between miles 91 and 101 AHP) identified a mooring area for gaming vessels that had seen the fewest "historical allisions on the left bank." The study acknowledged, however, that no area of the left descending bank of the river had been completely free of vessel strikes during the 11-year period studied.

Despite this history of sensitivity to risk within the port area, the Riverwalk complex, including the condominium garage and the Hilton Hotel Riverside, were constructed on old warehouse piers on the river side of the levee. This location offered no "crush zone" that could absorb the impact of a marine ramming, and despite the fact that the piers themselves were not built to withstand being struck by a heavy vessel, no physical barriers were constructed outboard of the new buildings to offer them protection.

In contrast, the 1987 Audubon Institute-sponsored risk assessment similarly determined that there had been few allisions at the Bienville Street wharf and that because it is high up in the bend, it faced low risk of being struck by an outbound vessel. Nonetheless, recognizing low incidence, but a potential for high consequences, the Audubon Institute placed the Aquarium of the Americas behind the levee with a 100-foot buffer zone to protect the shoreside structure. No similar safety feature was considered or constructed for the Hilton Hotel or the Riverwalk Marketplace.

Several passenger vessels, including gaming, tour and cruise vessels, were allowed to dock along the left descending bank, the side of the river at highest risk. Had the *Bright Field* lost power some time later and the same accident scenario evolved, the ship would likely have rammed the gambling vessel, resulting in substantial loss of life. The cruise vessels, which had even less warning time, would quite likely also have sustained serious passenger injuries or loss of life.

While silting around the vessels' docking areas may offer some protection from ramming by deep-draft vessels at average river stages, the silt layer did not reduce water depth sufficiently to retard a runaway ship when the river was high, as it was on the day of the *Bright Field* accident. The property owners and other stakeholders within the Port of New Orleans clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded that the Coast Guard, the Dock Board, and the property owners did not adequately address the risks posed to moored vessels along the Erato, Julia, Poydras, and Canal Street wharves; as a result, under certain conditions, those vessels were vulnerable to ramming by other marine traffic.

Questionnaires were sent to 74 persons who had been either in or near the Riverwalk Marketplace when the accident occurred or who were among the passengers and crew of the *Queen of New Orleans* or *Creole Queen* at the time of the allision. A total of 12 responses were received from individuals who said they had been aboard the *Queen of New Orleans* when the *Bright Field* struck the wharf.

According to the *Queen of New Orleans' Emergency Evacuation Plan for Moored Conditions*, the vessel can be exited only from the bow section of the second deck. The plan states that to evacuate the vessel in an emergency, every passenger is to be directed to this gangway. The owner of the vessel noted that three portable emergency gangways, which are designed to be used in the event the main gangway is inoperable, are aboard the vessel. The vessel's emergency evacuation plan, however, does not refer to these portable gangways, or provide instructions on how to make them operable in an emergency, or give guidance for directing passengers to them. The evacuation plan also does not take into account the time needed to alert the crew to take action or for crewmembers to stage the portable gangways and assure their safe operation. Because the emergency gangways were not used during the *Bright Field* accident, the only exit available was the second deck bow gangway.

While the Safety Board recognizes that the number of questionnaire responses was small relative to the number of passengers aboard the vessel, the responses are nevertheless meaningful and illustrate the panic induced when the crowd was confronted with no means of escape from a vessel directly threatened by an oncoming freighter. Furthermore, had the vessel been filled to its capacity of 1,800 passengers and crewmembers, the number of persons unable to evacuate in time could have been significantly higher. The ensuing panic most likely would have been more hazardous, possibly resulting in a higher number of, and more severe, injuries. The Safety Board concluded that evacuation of the *Queen of New Orleans* was hampered, and passenger risk increased, by the fact that only one gangway was made available for passenger egress during the emergency.

The *Creole Queen*, a New Orleans Paddlewheels, Inc., excursion vessel with a capacity of 1,000 passengers and crew, was docked astern of the *Queen of New Orleans*. At the time of the accident, 190 passengers and crewmembers were aboard. Following the master's instructions to evacuate, passengers exited the vessel across a single dockside gangway. When the bow wave from the *Bright Field* passed the *Creole Queen*, the gangway dropped from the side of the vessel, and three passengers on the gangway fell into the river. One passenger was seriously injured; the other two sustained minor injuries. By this time, approximately one half of the *Creole Queen*'s passengers had been evacuated. The remaining passengers could not exit the vessel until the gangway was repositioned.

The Safety Board concluded that New Orleans Paddlewheels, Inc., must make better provisions for all its vessels in the event of an impending allision or other emergency. Consequently, the Safety Board issued the following safety recommendations to New Orleans Paddlewheels, Inc., on September 5, 1997:

> Work with the U.S. Coast Guard to review the *Emergency Evacuation Plan for Moored Conditions* of the *Queen of New Orleans* and amend it regarding current

> evacuation procedures and the number of immediately accessible gangways and disembarkation locations, to ensure timely and orderly exiting of passengers in the event of emergency evacuation. (M-97-62)
>
> Work with the U.S. Coast Guard to develop and implement procedures for evacuation under moored or docked conditions for all your excursion vessels to ensure that passengers can exit each vessel in a timely and orderly manner should an emergency evacuation be necessary. (M-97-63)

In a September 29, 1997, letter to the Safety Board, New Orleans Paddlewheels, Inc., replied that its emergency evacuation plan for the *Queen of New Orleans* in moored conditions

> addresses the evacuation of all areas on board the vessel. We purposely did not include portable gangways because they are to be used only when the primary evacuation gangway is inoperable. Our deck crew is regularly trained and drilled on how to use these portable gangways in multiple locations.

The Safety Board is concerned that the evacuation plan for the *Queen of New Orleans* does not provide a readily available additional means of escape that does not require staging in an emergency. The Safety Board's intent in issuing Safety Recommendation M-97-62 was to prompt New Orleans Paddlewheels, Inc., to amend the *Queen of New Orleans*'s *Evacuation Plan for Moored Conditions* not only to enhance evacuation procedures, but also to address the need to provide for more than one immediately accessible disembarkation location to ensure a timely and orderly exiting of passengers.

Further, although the September 29 letter states that the deck crew is trained and drilled on use of the portable gangways, the letter does not address the training of the nonoperating crewmembers, who are responsible for assisting passengers to the egress areas of the vessel during emergencies. The *Evacuation Plan for Moored Conditions* provides no guidance on the use of portable gangways to the numerous nonoperating crew on board the vessel who are responsible for directing passengers and assisting their escape. Moreover, the specific plan to which all crewmembers are to look for guidance in responding to emergency situations does not provide any information on these gangways or how to guide passengers to them. Based on the failure of New Orleans Paddlewheels, Inc., to effectively address these concerns, the Safety Board classifies Safety Recommendation M-97-62 "Closed--Unacceptable Action." New Orleans Paddlewheels, Inc., has not responded to Safety Recommendation M-97-63 concerning the development of evacuation procedures for moored or docked conditions for all its excursion vessels. Therefore, Safety Recommendation M-97-63 remains classified "Open--Await Response."

The Safety Board, also on September 5, 1997, issued the following safety recommendation to the Coast Guard:

> Work with New Orleans Paddlewheels, Inc., to review and amend the *Emergency Evacuation Plan for Moored Conditions* of the *Queen of New Orleans* regarding current evacuation procedures and the number of immediately accessible

> gangways and disembarkation locations, and to develop and implement procedures for evacuation under moored or docked conditions for all New Orleans Paddlewheels, Inc., excursion vessels to ensure that passengers can exit each vessel in a timely and orderly manner should an emergency evacuation be necessary. (M-97-59)

In a November 18, 1997, letter, the Coast Guard responded that the New Orleans captain of the port had already required a review of evacuation procedures for all high-capacity gaming vessels, but that the Coast Guard believes this safety recommendation should be expanded to cover all passenger vessels operating in the Mississippi River in the New Orleans area. The letter stated the Coast Guard's belief that,

> It would be prudent to develop reasonable, practical and appropriate evacuation criteria for the different types of passenger vessels based upon their type, configuration, passenger and crew capacity, and the extent which passengers are normally aboard the vessel while dockside. To this end, we have discussed the expansion of this recommendation with Captain of the Port New Orleans and will require further review and development of this initiative.

The Safety Board is pleased that the Coast Guard has not only addressed the specific intent of Safety Recommendation M-97-59 regarding the *Queen of New Orleans*, but has also expanded the scope of the recommendation to cover all high-capacity passenger vessels operating within the Port of New Orleans. While the Coast Guard response does not specifically address evacuation plans for New Orleans Paddlewheels excursion vessels, the Safety Board notes that these vessels will be covered by the evacuation criteria the Coast Guard plans to develop for all passenger vessels operating in the New Orleans area of the Mississippi River. Pending further information from the Coast Guard regarding the proposed review of evacuation plans for such vessels, and specifically those vessels belonging to New Orleans Paddlewheels, Inc., the Safety Board classifies Safety Recommendation M-97-59 "Open--Acceptable Response."

Under River Front Alert Network procedures established after this accident, individual riverfront commercial properties were to make their own determinations about the proper actions to be taken after receiving notification of an emergency involving a vessel on the river. According to evacuation plans that were initially in effect for property tenants, a lengthy procedural chain of command was in place that could delay a decision to evacuate. In the view of the Safety Board, such a potential for delay could endanger the employees and patrons of riverfront properties. Therefore, on September 5, 1997, the Safety Board issued the following safety recommendation to the New Orleans Dock Board:

> Develop, as part of the River Front Alert Network, an emergency evacuation announcement for broadcast by the harbor police department dispatcher using a public address system linked to river front properties that provides for a timely and efficient evacuation in the event of an impending collision or other emergency. (M-97-60)

Documentation received by the Safety Board on November 3, 1997, outlining the actions to be taken in the event of the activation of the River Front Alert Network appears to address the Safety Board concerns that prompted the issuance of Safety Recommendation M-97-60. Under the specific evacuation protocols developed for responding to the activation of the River Front Alert Network, the procedural chains of command within each property's evacuation plans have been eliminated, and property security officers have been given authority to initiate an evacuation immediately upon hearing a River Front Alert Network broadcast and assessing the danger. Because these revised evacuation plans meet the intent of the safety recommendation, the Safety Board classifies Safety Recommendation M-97-60 "Closed--Acceptable Action."

The River Front Alert Network system did not require that vessels docked or moored in its vicinity monitor the alert broadcast from the Coast Guard traffic light operator to the harbor police dispatcher indicating a vessel irregularity or loss of steering in the vicinity of the riverfront properties. The Safety Board was concerned that, unless these vessels monitored the network for emergency broadcasts, vessel occupants would be subject to delays in notification similar to those that occurred in this accident and that contributed to the disorderly evacuation and numerous injuries. Therefore, on September 5, 1997, the Safety Board issued the following safety recommendation to the New Orleans Dock Board:

> Require all vessels which dock or moor in the area encompassed by the River Front Alert Network to monitor the River Front Alert Network radio for any emergency broadcast to provide maximum advance notice of an emergency. (M-97-61)

In a September 15, 1997, reply to the Safety Board, the Dock Board said that the intent of this safety recommendation should be met by the postaccident COTP order requiring that all large passenger vessels docked in the area have a manned pilothouse and that they monitor all emergency and working marine channels. While agreeing that monitoring working and emergency radio channels should give moored passenger vessels advance warning of potentially hazardous situations on the river, the Safety Board notes that the COTP order requiring such monitoring was an interim, and possibly temporary, measure. The Coast Guard has since published an interim rule that, when issued as a final rule, will make permanent the COTP order. In anticipation that the interim rule regarding manned pilothouses and radio monitoring will become permanent as 33 CFR 165.810(e), the Safety Board classifies Safety Recommendation M-97-61 "Closed--No Longer Applicable."

Also on September 5, 1997, the Safety Board issued the following safety recommendation to the Coast Guard:

> Require that all commercial vessels that operate within the River Front Alert Network zone participate in the network and notify the U.S. Coast Guard traffic light operator whenever they experience an irregularity or abnormality that could result in a safety risk to the Port of New Orleans area. (M-97-58)

In its November 18, 1997, letter to the Safety Board, the Coast Guard stated that existing regulations and local marine practice are now serving to meet the intent of this safety recommendation. The letter stated that,

> 3 CFR 160.215 requires vessels to immediately notify the nearest Marine Safety Office or Group of hazardous conditions aboard or caused by the vessel. Currently, the vessels in the vicinity of the traffic light notify the traffic light operator who is responsible to the Marine Safety Office. Through 33 CFR 26.03 or existing Captain of the Port orders, ALL vessels, including moored passenger vessels, must monitor Channel 67 VHF. Therefore, when a hazardous condition is reported to the traffic light operator, he activates the Riverfront Alert Network by calling the Harbor Police on the Network radio. The police then notify the impacted participating facilities and vessels. Between the Channel 67 notifications and subsequent Riverfront Alert Network radio calls, ALL vessels and facilities are notified.

Based on this response, the Safety Board classifies Safety Recommendation M-97-58 "Closed--Acceptable Action."

At the time the vessel lost propulsion, the *Bright Field* was operating at full speed in high-river and high-current conditions. In his testimony, the pilot claimed that it was necessary to operate the *Bright Field* at maximum speed to attain reasonable maneuverability of the vessel in the operating environment of high water, rapid current, and a heavily laden ship designed to be maneuverable at lower speeds.

Several days after the accident, Safety Board investigators boarded a fully loaded vessel of similar size, displacement, and power to the *Bright Field* that was operating downbound in similar high water conditions. During this transit, the pilot did not use full speed to maneuver the ship. Each ship handles differently, but the operation of the *Bright Field* at full speed left no margin for error. For example, the main engine tripped off line because of a temporary loss of lubricating oil pressure. The oil pressure and engine operation were restored within about 2 minutes, which is a reasonable amount of time. However, operating at full speed in high-river conditions, the ship had no room to maneuver out of the emergency. The Safety Board concluded that operating a vessel at full speed in the restricted waters of the Mississippi River may not allow sufficient time or distance to recover from an emergency.

High-river conditions are repeatedly cited as cause for concern. For example, various port risk assessments cite local experts, in interviews and in response to questionnaires, clearly expressing that high river stage is an important factor in river casualties. This opinion is strongly supported by available data. Eleven years of casualty data from the Port of New Orleans and the Coast Guard clearly show a seasonal trend to river casualties. The high-water months of February, March, April, and May experience two to three times the casualties that occur during the low-water months of July through October.

In addition, the studies point out that the Coast Guard acknowledges the fast Mississippi River current and low seasonal water temperatures as creating a very hostile environment. No

matter how many Coast Guard, State, local, and other resources respond to a casualty involving a large number of persons in the water, it would be difficult to rescue everyone. The Coast Guard 1994 search and rescue exercise lead to the conclusion that, under adverse conditions, the Coast Guard could expect to rescue and save only a small percentage of the people in the water. This finding should be unacceptable to the Coast Guard and the Port of New Orleans, and the two agencies should consider alternative means to deal with this emergency. For example, prior to the *Bright Field* accident, the Bonnet Carré Spillway had only been opened seven times to alleviate high-water conditions, apparently because of the cumbersome and lengthy tasks necessary to do so. Nonetheless, the risks associated with high water and rapid current were considered "unusual" enough that in March 1997, the spillway was opened for the eighth time. The Port of New Orleans, the Coast Guard, and the Corps of Engineers might consider more aggressive use of the Bonnet Carré Spillway to alleviate these high-water conditions and to deal with the safety issues created by them. Further, if the major impediment to opening the spillway is the time and effort it takes to do so, it may be appropriate for the Corps of Engineers to consider ways to make the spillway more usable and to employ it for risk mitigation as well as for flood control.

No practical physical barrier aboard ship exists that will safely stop a runaway vessel. In such an emergency, a safe outcome depends on the successful interaction of several physical and operational factors. For example, if main engine power is lost, adequate steering can usually be maintained until the ship slows enough for the anchors to be dropped. If a vessel loses its steering, engine power can be used to either slow the vessel (astern power) or, if it is a twin-screw vessel, to maneuver the ship.

Anchors are perceived as providing some level of protection by serving as "brakes" that will stop or at least slow a ship. But anchors are neither designed nor adequate for stopping a heavily loaded ship traveling at high speed. Had the *Bright Field*'s anchors been released, the anchor chain would quite likely have payed out at a speed that could not be controlled by the windlass brake, and the chain would simply have continued to run out until it parted from the ship. In this accident, the dropping of the anchor and paying out of chain could not have been expected to significantly slow, let alone stop, the ship.

Since this accident, the Coast Guard has placed renewed emphasis on having anchors at the ready (backed out of the hawsepipe, disengaged from the windlass, and being held by the brake), with a two-person forecastle watch. While having the anchors manned and at the ready may prove beneficial in certain circumstances, it is unlikely to achieve anything meaningful aboard a heavy vessel operating at relatively high speeds in the Mississippi River. Further, "increased emphasis" on having the anchors at the ready may even provide a false sense of security without effectively addressing the dangers inherent in operating heavy vessels at high speed in proximity to shoreside businesses and other marine traffic.

The Coast Guard has overall responsibility for maintaining public safety in the Port of New Orleans area. Under the *Ports and Waterways Safety Act of 1972*, the Congress charged the Coast Guard with monitoring and managing risk in all U.S. ports and taking actions to maintain risk at an acceptable level. In carrying out this role, the Coast Guard must assess and manage the risk that is inherent in all commercial activities within U.S. ports. In fact, in its *1996*

Performance Report, the Coast Guard's Office of Marine Safety and Environmental Protection asserts that managing risk is its primary mission. The Safety Board concurs with this assessment and notes that the Coast Guard has the authority, the responsibility, and the experience to direct a comprehensive assessment of risk in the Port of New Orleans.

Among the factors that must be considered are risks associated with relatively high-speed navigation of the river, high river stage and rapid river current, railroad and highway bridges spanning the waterway, and the carriage of cargoes such as bulk oil or other hazardous materials or chemicals that can cause pollution, fire, or explosion. The Safety Board notes that many of the risk factors associated with river commerce within the port area have already been identified in previous risk-assessment studies and, further, that these factors may be amenable to known risk-reduction or risk-mitigation initiatives. Such initiatives might include reducing vessel speed, opening the Bonnet Carré Spillway on a more regular basis, using tugboats either as escorts or as a "barrier" to protect marine assets, adequately assessing the protection afforded by silting-in of vulnerable areas, and moving the passenger vessels to a safer location.

As a result of its investigation of the *Bright Field* accident, the National Transportation Safety Board makes the following safety recommendations to the U.S. Coast Guard:

> In cooperation with the Board of Commissioners of the Port of New Orleans, reassess the risk of locating passenger vessels along the left descending bank of the Mississippi River and determine whether to remove the vessels to a less vulnerable location or put in place procedural, operational, or physical barriers that will protect these vessels from ramming by riverborne traffic. (M-98-1)
>
> Conduct, with the cooperation of all stakeholders, a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-2)
>
> Take the lead in working with the pilot associations serving the Port of New Orleans to evaluate the impact of operating vessels at full speed in the Mississippi River and incorporate that information in your risk-management and risk-reduction strategies for the port area. (M-98-3)
>
> In cooperation with the appropriate stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that will ensure the safety of people and property within the Port of New Orleans.(M-98-4)

Also, the Safety Board issued Safety Recommendations M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-7 and -8 to the State of Louisiana; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-98-13 through -15 to International RiverCenter; M-98-16 through -18 to Clearsky Shipping Company; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots Association; M-98-27 and -28 to the Crescent River Port Pilots Association; and M-98-29 and -30 to Associated Federal Pilots and Docking Masters of Louisiana, Inc.

Please refer to Safety Recommendations M-98-1 through -4 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-5 and -6

Lieutenant General Joe N. Ballard
Commanding General
U.S. Army Corps of Engineers
20 Massachusetts Avenue
Washington, D.C. 20314-1000

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Board of Commissioners of the Port of New Orleans (the "Dock Board"), the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the Dock Board, had commissioned partial risk assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field.*

For example, risk assessment projects predicted an increase in accidents involving collisions, rammings, and groundings due to increased river traffic. The Louisiana State University risk assessment project, in 1994, concluded that no sections of the Port of New Orleans waterfront were free of ship allisions, including the area where the high-capacity passenger vessels, gaming vessels, and riverfront properties were located. Analysis of accident

[1]For more detailed information, read Marine Accident Report—*Allision of the Liberian Freighter* Bright Field *with the Poydras Street Wharf, Riverwalk Marketplace, and New Orleans Hilton Hotel in New Orleans, Louisiana, December 14, 1996.* (NTSB/MAR-98/01).

data for the Port of New Orleans from 1983 through 1993 (a total of 166 rammings along the left descending bank between miles 91 and 101 AHP) identified a mooring area for gaming vessels that had seen the fewest "historical allisions on the left bank." The study acknowledged, however, that no area of the left descending bank of the river had been completely free of vessel strikes during the 11-year period studied.

Despite this history of sensitivity to risk within the port area, the Riverwalk complex, including the condominium garage and the Hilton Hotel Riverside, were constructed on old warehouse piers on the river side of the levee. This location offered no "crush zone" that could absorb the impact of a marine ramming, and despite the fact that the piers themselves were not built to withstand being struck by a heavy vessel, no physical barriers were constructed outboard of the new buildings to offer them protection.

In contrast, the 1987 Audubon Institute-sponsored risk assessment similarly determined that there had been few allisions at the Bienville Street wharf and that because it is high up in the bend, it faced low risk of being struck by an outbound vessel. Nonetheless, recognizing low incidence, but a potential for high consequences, the Audubon Institute placed the Aquarium of the Americas behind the levee with a 100-foot buffer zone to protect the shoreside structure. No similar safety feature was considered or constructed for the Hilton Hotel or the Riverwalk Marketplace.

International RiverCenter (IRC) obtained construction permits for the riverside expansion of the hotel from the city of New Orleans, the Corps of Engineers, and the New Orleans Levee Board. In addition, the construction plans were approved by the Dock Board. According to the Dock Board, it may make recommendations to the IRC or other stakeholders in the area to widen the wharf, to allow silt to accumulate, or to further increase the robustness of construction in the area immediately outbound of their structures; however, it has no authority to compel such action. Currently, the damaged portions of the Riverwalk Marketplace mall, the parking deck, and the Hilton Hotel are being rebuilt in the same location. No physical barriers have been included in the rebuilding of these facilities. As with the initial construction, all permits were granted, and all plans were approved.

Furthermore, several passenger vessels, including gaming, tour and cruise vessels, were allowed to dock along the left descending bank, the side of the river at highest risk. Had the *Bright Field* lost power some time later and the same accident scenario evolved, the ship would likely have rammed the gambling vessel, resulting in substantial loss of life. The cruise vessels, which had even less warning time, would quite likely also have sustained serious passenger injuries or loss of life.

While silting around the vessels' docking areas may offer some protection from ramming by deep-draft vessels at average river stages, the silt layer did not reduce water depth sufficiently to retard a runaway ship when the river was high, as it was on the day of the *Bright Field* accident. Additionally, no tugboats were used either as escorts or as a "barrier" to prevent a runaway ship from ramming the shore or colliding with another marine asset. And no environmental controls, such as the Corps of Engineers' opening of the Bonnet Carré Spillway, were put in place to reduce river flow or current.

High-river conditions are repeatedly cited as cause for concern. For example, various port risk assessments cite local experts, in interviews and in response to questionnaires, clearly expressing that high river stage is an important factor in river casualties. This opinion is strongly supported by available data. Eleven years of casualty data from the Port of New Orleans and the Coast Guard clearly show a seasonal trend to river casualties. The high-water months of February, March, April, and May experience two to three times the casualties that occur during the low-water months of July through October.

Prior to the *Bright Field* accident, the Bonnet Carré Spillway had only been opened seven times to alleviate high-water conditions, apparently because of the cumbersome and lengthy tasks necessary to do so. Nonetheless, the risks associated with high water and rapid current were considered "unusual" enough that in March 1997, the spillway was opened for the eighth time. The Port of New Orleans, the Coast Guard, and the Corps of Engineers might consider more aggressive use of the Bonnet Carré Spillway to alleviate these high-water conditions and to deal with the safety issues created by them. Further, if the major impediment to opening the spillway is the time and effort it takes to do so, it may be appropriate for the Corps of Engineers to consider ways to make the spillway more usable and to employ it for risk mitigation as well as for flood control.

The property owners and other stakeholders within the Port of New Orleans clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded, however, that the stakeholders within the Port of New Orleans, including Federal, State, and local agencies; private commercial entities; shipowners, and pilot associations have not determined the overall level of risk associated with the full range of activities within the port area and have not provided adequate protection for persons and property in that area.

The National Transportation therefore makes the following safety recommendations to the U.S. Army Corps of Engineers:

> Participate with the U.S. Coast Guard and other stakeholders in a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-5)
>
> In cooperation with the U.S. Coast Guard and other stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that will ensure the safety of people and property within the Port of New Orleans. (M-98-6)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-7 and -8 to the State of Louisiana; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-98-13 through -15 to International RiverCenter; M-98-16 through -18 to Clearsky Shipping Company; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots

Association; M-98-27 and -28 to the Crescent River Port Pilots Association; and M-98-29 and -30 to Associated Federal Pilots and Docking Masters of Louisiana, Inc.

Please refer to Safety Recommendations M-98-5 and -6 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-7 and -8

Mike Foster
Governor
State of Louisiana
Post Office Box 94004
Baton Rouge, Louisiana 70804-9004

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the failure of Clearsky Shipping Company to adequately manage and oversee the maintenance of the engineering plant aboard the *Bright Field*, with the result that the vessel temporarily lost power while navigating a high-risk area of the Mississippi River. Contributing to the amount of property damage and the number and types of injuries sustained during the accident was the failure of the U.S. Coast Guard, the Board of Commissioners of the Port of New Orleans, and International RiverCenter, Inc., to adequately assess, manage, or mitigate the risks associated with locating unprotected commercial enterprises in areas vulnerable to vessel strikes.

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Board of Commissioners of the Port of New Orleans (the "Dock Board"), the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the Dock Board, had commissioned partial risk

[1] For more detailed information, read Marine Accident Report—*Allision of the Liberian Freighter* Bright Field *with the Poydras Street Wharf, Riverwalk Marketplace, and New Orleans Hilton Hotel in New Orleans, Louisiana, December 14, 1996.* (NTSB/MAR-98/01).

assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field*.

For example, risk assessment projects predicted an increase in accidents involving collisions, rammings, and groundings due to increased river traffic. The Louisiana State University risk assessment project, in 1994, concluded that no sections of the Port of New Orleans waterfront were free of ship allisions, including the area where the high-capacity passenger vessels, gaming vessels, and riverfront properties were located. Analysis of accident data for the Port of New Orleans from 1983 through 1993 (a total of 166 rammings along the left descending bank between miles 91 and 101 AHP) identified a mooring area for gaming vessels that had seen the fewest "historical allisions on the left bank." The study acknowledged, however, that no area of the left descending bank of the river had been completely free of vessel strikes during the 11-year period studied.

Despite this history of sensitivity to risk within the port area, the Riverwalk complex, including the condominium garage and the Hilton Hotel Riverside, were constructed on old warehouse piers on the river side of the levee. This location offered no "crush zone" that could absorb the impact of a marine ramming, and despite the fact that the piers themselves were not built to withstand being struck by a heavy vessel, no physical barriers were constructed outboard of the new buildings to offer them protection.

In contrast, the 1987 Audubon Institute-sponsored risk assessment similarly determined that there had been few allisions at the Bienville Street wharf and that because it is high up in the bend, it faced low risk of being struck by an outbound vessel. Nonetheless, recognizing low incidence, but a potential for high consequences, the Audubon Institute placed the Aquarium of the Americas behind the levee with a 100-foot buffer zone to protect the shoreside structure. No similar safety feature was considered or constructed for the Hilton Hotel or the Riverwalk Marketplace.

The International RiverCenter (IRC) obtained construction permits for the riverside expansion of the hotel from the city of New Orleans, the Corps of Engineers, and the Orleans Levee Board. In addition, the construction plans were approved by the Dock Board. According to the Dock Board, it may make recommendations to the IRC or other stakeholders in the area to widen the wharf, to allow silt to accumulate, or to further increase the robustness of construction in the area immediately outbound of their structures; however, it has no authority to compel such action. Currently, the damaged portions of the Riverwalk Marketplace mall, the parking deck, and the Hilton Hotel are being rebuilt in the same location. No physical barriers have been included in the rebuilding of these facilities. As with the initial construction, all permits were granted, and all plans were approved.

Furthermore, several passenger vessels, including gaming, tour and cruise vessels, were allowed to dock along the left descending bank, the side of the river at highest risk. Had the *Bright Field* lost power some time later and the same accident scenario evolved, the ship would likely have rammed the gambling vessel, resulting in substantial loss of life. The cruise vessels,

which had even less warning time, would quite likely also have sustained serious passenger injuries or loss of life.

While silting around the vessels' docking areas may offer some protection from ramming by deep-draft vessels at average river stages, the silt layer did not reduce water depth sufficiently to retard a runaway ship when the river was high, as it was on the day of the *Bright Field* accident. Additionally, no tugboats were used either as escorts or as a "barrier" to prevent a runaway ship from ramming the shore or colliding with another marine asset. And no environmental controls, such as the Corps of Engineers' opening of the Bonnet Carré Spillway, were put in place to reduce river flow or current.

The property owners and other stakeholders within the Port of New Orleans clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded, however, that the stakeholders within the Port of New Orleans, including Federal, State, and local agencies; private commercial entities; shipowners, and pilot associations have not determined the overall level of risk associated with the full range of activities within the port area and have not provided adequate protection for persons and property in that area.

As noted above, many of the risk factors associated with river commerce within the port area have already been identified in previous risk-assessment studies. The Safety Board believes that these factors may be amenable to known risk-reduction or risk-mitigation initiatives. Such initiatives might include reducing vessel speed, opening the spillway on a more regular basis, using tugboats either as escorts or as a "barrier" to protect marine assets, or moving the passenger vessels to a safer location.

The National Transportation therefore makes the following safety recommendations to the State of Louisiana:

> Participate with the U.S. Coast Guard and other stakeholders in a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-7)
>
> In cooperation with the U.S. Coast Guard and other stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that will ensure the safety of people and property within the Port of New Orleans. (M-98-8)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-98-13 through -15 to International RiverCenter; M-98-16 through -18 to Clearsky Shipping Company; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots Association; M-98-27 and -28 to the Crescent River Port Pilots Association; and M-98-29 and -30 to Associated Federal Pilots and Docking Masters of Louisiana, Inc.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-98-7 and -8 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-9 through -12

Mr. J. Ron Brinson
President and Chief Executive Officer
Board of Commissioners of the Port of New Orleans
Post Office Box 60046
New Orleans, Louisiana 70160

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the failure of Clearsky Shipping Company to adequately manage and oversee the maintenance of the engineering plant aboard the *Bright Field*, with the result that the vessel temporarily lost power while navigating a high-risk area of the Mississippi River. Contributing to the amount of property damage and the number and types of injuries sustained during the accident was the failure of the U.S. Coast Guard, the Board of Commissioners of the Port of New Orleans, and International RiverCenter, Inc., to adequately assess, manage, or mitigate the risks associated with locating unprotected commercial enterprises in areas vulnerable to vessel strikes.

Under River Front Alert Network procedures established after this accident, individual riverfront commercial properties were to make their own determinations about the proper actions to be taken after receiving notification of an emergency involving a vessel on the river. According to evacuation plans that were initially in effect for property tenants, a lengthy procedural chain of command was in place that could delay a decision to evacuate. In the view of the Safety Board, such a potential for delay could endanger the employees and patrons of

[1] For more detailed information, read Marine Accident Report—*Allision of the Liberian Freighter* Bright Field *with the Poydras Street Wharf, Riverwalk Marketplace, and New Orleans Hilton Hotel in New Orleans, Louisiana, December 14, 1996.* (NTSB/MAR-98/01).

riverfront properties. Therefore, on September 5, 1997, the Safety Board issued the following safety recommendation to the New Orleans Dock Board:

> Develop, as part of the River Front Alert Network, an emergency evacuation announcement for broadcast by the harbor police department dispatcher using a public address system linked to river front properties that provides for a timely and efficient evacuation in the event of an impending collision or other emergency. (M-97-60)

Documentation received by the Safety Board on November 3, 1997, outlining the actions to be taken in the event of the activation of the River Front Alert Network appears to address the Safety Board concerns that prompted the issuance of Safety Recommendation M-97-60. Under the specific evacuation protocols developed for responding to the activation of the River Front Alert Network, the procedural chains of command within each property's evacuation plans have been eliminated, and property security officers have been given authority to initiate an evacuation immediately upon hearing a River Front Alert Network broadcast and assessing the danger. Because these revised evacuation plans meet the intent of the safety recommendation, the Safety Board classifies Safety Recommendation M-97-60 "Closed--Acceptable Action."

The River Front Alert Network system did not require that vessels docked or moored in its vicinity monitor the alert broadcast from the Coast Guard traffic light operator to the harbor police dispatcher indicating a vessel irregularity or loss of steering in the vicinity of the riverfront properties. The Safety Board was concerned that, unless these vessels monitored the network for emergency broadcasts, vessel occupants would be subject to delays in notification similar to those that occurred in this accident and that contributed to the disorderly evacuation and numerous injuries. Therefore, on September 5, 1997, the Safety Board issued the following safety recommendation to the New Orleans Dock Board:

> Require all vessels which dock or moor in the area encompassed by the River Front Alert Network to monitor the River Front Alert Network radio for any emergency broadcast to provide maximum advance notice of an emergency. (M-97-61)

In a September 15, 1997, reply to the Safety Board, the Dock Board said that the intent of this safety recommendation should be met by the postaccident COTP order requiring that all large passenger vessels docked in the area have a manned pilothouse and that they monitor all emergency and working marine channels. While agreeing that monitoring working and emergency radio channels should give moored passenger vessels advance warning of potentially hazardous situations on the river, the Safety Board notes that the COTP order requiring such monitoring was an interim, and possibly temporary, measure. The Coast Guard has since published an interim rule that, when issued as a final rule, will make permanent the COTP order. In anticipation that the interim rule regarding manned pilothouses and radio monitoring will become permanent as 33 CFR 165.810(e), the Safety Board classifies Safety Recommendation M-97-61 "Closed--No Longer Applicable."

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Dock Board, the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the Dock Board, had commissioned partial risk assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field.*

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Despite this history of sensitivity to risk within the port area, the Riverwalk complex, including the condominium garage and the Hilton Hotel Riverside, were constructed on old warehouse piers on the river side of the levee. This location offered no "crush zone" that could absorb the impact of a marine ramming, and despite the fact that the piers themselves were not built to withstand being struck by a heavy vessel, no physical barriers were constructed outboard of the new buildings to offer them protection.

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The International RiverCenter (IRC) obtained construction permits for the riverside expansion of the hotel from the city of New Orleans, the Corps of Engineers, and the Orleans Levee Board. In addition, the construction plans were approved by the Dock Board. According to the Dock Board, it may make recommendations to the IRC or other stakeholders in the area to widen the wharf, to allow silt to accumulate, or to further increase the robustness of construction in the area immediately outbound of their structures; however, it has no authority to compel such action. Currently, the damaged portions of the Riverwalk Marketplace mall, the parking deck, and the Hilton Hotel are being rebuilt in the same location. No physical barriers have been

included in the rebuilding of these facilities. As with the initial construction, all permits were granted, and all plans were approved.

Given the hazardous operating environment in the Port of New Orleans and the number of instances of loss of propulsion and steering, any number of which could have resulted in similar accidents or far more serious ones, the Safety Board does not understand the property owners' reluctance to provide adequate barriers to protect their assets in the port area. Although the River Front Alert Network is a commendable effort to alert the harbor police and security officers in the event of a need to evacuate the area, such efforts are unlikely to result in a complete evacuation under even slightly different circumstances. For example, the *Bright Field* rammed the Hilton Hotel during daylight hours when, fortunately, few guests were occupying rooms and no cleaning personnel were in the immediate area. Had this accident occurred during the evening, at night, or in the morning hours, most of the rooms would probably have been occupied. It is unlikely that even the River Front Alert Network would have been able to awaken the sleeping guests, alert them to the danger, and evacuate them in time to prevent serious injury or possible death.

The Safety Board is concerned that, despite the historical record of marine incidents and accidents in that section of the Mississippi River, the Dock Board permitted the placement of a commercial facility within about 20 feet of an unprotected wharf. More than 13,500 people a day visit the Riverwalk Marketplace. Those visitors have a reasonable expectation that the Port of New Orleans will assert its responsibility to protect their safety by exercising the power to disapprove a building plan that does not adequately account for a known risk. The Safety Board concluded that the IRC and the Dock Board did not conduct adequate risk assessment nor perform adequate safety management oversight to protect their properties and the people that use them from an allision such as that involving the *Bright Field*.

While the construction of a shopping mall and a hotel in such a high-risk area was ill-advised, the Safety Board recognizes that economy and practicality argue against attempting to correct the error by relocating those facilities. Nonetheless, the *Bright Field* accident highlights the risk to shoreside structures within the Port of New Orleans and the need to consider that risk in the approval process for future construction there.

Several passenger vessels, including gaming, tour and cruise vessels, were allowed to dock along the left descending bank of the river, the side of the river at highest risk. Had the *Bright Field* lost power some time later and the same accident scenario evolved, the ship would likely have rammed the gambling vessel, resulting in substantial loss of life. The cruise vessels, which had even less warning time, would quite likely also have sustained serious passenger injuries or loss of life.

While silting around the vessels' docking areas may offer some protection from ramming by deep-draft vessels at average river stages, the silt layer did not reduce water depth sufficiently to retard a runaway ship when the river was high, as it was on the day of the *Bright Field* accident. Additionally, no tugboats were used either as escorts or as a "barrier" to prevent a runaway ship from ramming the shore or colliding with another marine asset. And no

environmental controls, such as the Corps of Engineers' opening of the Bonnet Carré Spillway, were put in place to reduce river flow or current.

The property owners and other stakeholders within the Port of New Orleans clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded, however, that the stakeholders within the Port of New Orleans, including Federal, State, and local agencies; private commercial entities; shipowners, and pilot associations have not determined the overall level of risk associated with the full range of activities within the port area and have not provided adequate protection for persons and property in that area.

Among the factors that must be considered are risks associated with relatively high-speed navigation of the river, high river stage and rapid river current, railroad and highway bridges spanning the waterway, and the carriage of cargoes such as bulk oil or other hazardous materials or chemicals that can cause pollution, fire, or explosion. The Safety Board notes that many of the risk factors associated with river commerce within the port area have already been identified in previous risk-assessment studies and, further, that these factors may be amenable to known risk-reduction or risk-mitigation initiatives. Such initiatives might include reducing vessel speed, opening the Bonnet Carré Spillway on a more regular basis, using tugboats either as escorts or as a "barrier" to protect marine assets, adequately assessing the protection afforded by silting-in of vulnerable areas, and moving the passenger vessels to a safer location.

As a result of its investigation of the *Bright Field* accident, the National Transportation Safety Board makes the following safety recommendations to the Board of Commissioners of the Port of New Orleans:

> As part of the permit-approval process for new commercial and residential development along the wharves within your jurisdiction, require that any new construction of occupied space be sited behind a buffer zone sufficient to protect persons and property by safely absorbing the impact should a vessel strike the wharf. (M-98-9)
>
> In cooperation with the U.S. Coast Guard, reassess the risk of locating passenger vessels along the left descending bank of the Mississippi River and determine whether to remove the vessels to a less vulnerable location or put in place procedural, operational, or physical barriers that will protect these vessels from ramming by riverborne traffic. (M-98-10)
>
> Participate with the U.S. Coast Guard and other stakeholders in a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-11)
>
> In cooperation with the U.S. Coast Guard and other stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that

will ensure the safety of people and property within the Port of New Orleans. (M-98-12)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-7 and -8 to the State of Louisiana; M-98-13 through -15 to International RiverCenter; M-98-16 through -18 to Clearsky Shipping Company; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots Association; M-98-27 and -28 to the Crescent River Port Pilots Association; and M-98-29 and -30 to the Associated Federal Pilots and Docking Masters of Louisiana, Inc.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-98-9 through -12 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-13 through -15

Mr. Lester E. Kabacoff
General Partner
International RiverCenter
c/o Mr. Robert Carpenter
2 Poydras Street, Third Floor
New Orleans, Louisiana 70140

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the failure of Clearsky Shipping Company to adequately manage and oversee the maintenance of the engineering plant aboard the *Bright Field*, with the result that the vessel temporarily lost power while navigating a high-risk area of the Mississippi River. Contributing to the amount of property damage and the number and types of injuries sustained during the accident was the failure of the U.S. Coast Guard, the Board of Commissioners of the Port of New Orleans, and International RiverCenter, Inc., to adequately assess, manage, or mitigate the risks associated with locating unprotected commercial enterprises in areas vulnerable to vessel strikes.

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Dock Board, the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the

[1] For more detailed information, read Marine Accident Report—*Allision of the Liberian Freighter* Bright Field *with the Poydras Street Wharf, Riverwalk Marketplace, and New Orleans Hilton Hotel in New Orleans, Louisiana, December 14, 1996.* (NTSB/MAR-98/01).

Dock Board, had commissioned partial risk assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field.*

For example, risk assessment projects predicted an increase in accidents involving collisions, rammings, and groundings due to increased river traffic. The Louisiana State University risk assessment project, in 1994, concluded that no sections of the Port of New Orleans waterfront were free of ship allisions, including the area where the high-capacity passenger vessels, gaming vessels, and riverfront properties were located. Analysis of accident data for the Port of New Orleans from 1983 through 1993 (a total of 166 rammings along the left descending bank between miles 91 and 101 AHP) identified a mooring area for gaming vessels that had seen the fewest "historical allisions on the left bank." The study acknowledged, however, that no area of the left descending bank of the river had been completely free of vessel strikes during the 11-year period studied.

Despite this history of sensitivity to risk within the port area, the Riverwalk complex, including the condominium garage and the Hilton Hotel Riverside, were constructed on old warehouse piers on the river side of the levee. This location offered no "crush zone" that could absorb the impact of a marine ramming, and despite the fact that the piers themselves were not built to withstand being struck by a heavy vessel, no physical barriers were constructed outboard of the new buildings to offer them protection.

In contrast, the 1987 Audubon Institute-sponsored risk assessment similarly determined that there had been few allisions at the Bienville Street wharf and that because it is high up in the bend, it faced low risk of being struck by an outbound vessel. Nonetheless, recognizing low incidence, but a potential for high consequences, the Audubon Institute placed the Aquarium of the Americas behind the levee with a 100-foot buffer zone to protect the shoreside structure. No similar safety feature was considered or constructed for the Hilton Hotel or the Riverwalk Marketplace, which was placed about 20 feet of an unprotected wharf. Currently, the damaged portions of the Riverwalk Marketplace mall, the parking deck, and the Hilton Hotel are being rebuilt in the same location. No physical barriers have been included in the rebuilding of these facilities.

Given the hazardous operating environment in the Port of New Orleans and the number of instances of loss of propulsion and steering, any number of which could have resulted in similar accidents or far more serious ones, the Safety Board does not understand the property owners' reluctance to provide adequate barriers to protect their assets in the port area. Although the River Front Alert Network is a commendable effort to alert the harbor police and security officers in the event of a need to evacuate the area, such efforts are unlikely to result in a complete evacuation under even slightly different circumstances. For example, the *Bright Field* rammed the Hilton Hotel during daylight hours when, fortunately, few guests were occupying rooms and no cleaning personnel were in the immediate area. Had this accident occurred during the evening, at night, or in the morning hours, most of the rooms would probably have been occupied. It is unlikely that even the River Front Alert Network would have been able to awaken

the sleeping guests, alert them to the danger, and evacuate them in time to prevent serious injury or possible death. The Safety Board concluded that the IRC and the Dock Board did not conduct adequate risk assessment nor perform adequate safety management oversight to protect their properties and the people that use them from an allision such as that involving the *Bright Field.*

While the construction of a shopping mall and a hotel in such a high-risk area was ill-advised, the Safety Board recognizes that economy and practicality argue against attempting to correct the error by relocating those facilities. Nonetheless, the *Bright Field* accident highlights the risk to shoreside structures within the Port of New Orleans and the need to consider that risk in the approval process for future construction there. The Safety Board believes that the Dock Board, as part of the permit-approval process for new commercial and residential development along the wharves within its jurisdiction, should require that any new construction of occupied space be sited behind a buffer zone sufficient to protect persons and property by safely absorbing the impact should a vessel strike a wharf.

After this accident, the Dock Board, in effect, identified a buffer zone for the Riverwalk Marketplace. The Dock Board "encouraged" the IRC to widen the Upper Poydras Street wharf by 50 feet. The company had already widened the wharf by that amount in one area to accommodate a gaming vessel, and the Dock Board suggested that the remainder of the wharf be extended as well. The Safety Board concurs in this suggestion and believes that the IRC should enhance the safety of the patrons and employees of the Riverwalk complex by immediately undertaking to widen that length of the Poydras Street wharf that has not previously been extended. Such an extension prior to this accident would have added a "crush zone" that would probably have prevented the structural damage and threat to persons that resulted from the *Bright Field* accident.

The property owners and other stakeholders within the Port of New Orleans, including International RiverCenter, clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded, however, that the stakeholders within the Port of New Orleans, including Federal, State, and local agencies; private commercial entities; shipowners, and pilot associations have not determined the overall level of risk associated with the full range of activities within the port area and have not provided adequate protection for persons and property in that area. As noted above, many of the risk factors associated with river commerce within the port area have already been identified in previous risk-assessment studies. The Safety Board believes that these factors may be amenable to known risk-reduction or risk-mitigation initiatives.

As a result of its investigation of the *Bright Field* accident, the National Transportation Safety Board makes the following safety recommendations to International RiverCenter:

> As previously suggested by the Board of Commissioners of the Port of New Orleans, immediately enhance the safety of the patrons and employees of the Riverwalk complex by widening, by a minimum of 50 feet, that length of the Poydras Street wharf that has not previously been extended. (M-98-13)

Participate with the U.S. Coast Guard and other stakeholders in a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-14)

In cooperation with the U.S. Coast Guard and other stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that will ensure the safety of people and property within the Port of New Orleans. (M-98-15)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-7 and -8 to the State of Louisiana; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-98-16 through -18 to Clearsky Shipping Company; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots Association; M-98-27 and -28 to the Crescent River Port Pilots Association; and M-98-29 and -30 to the Associated Federal Pilots and Docking Masters of Louisiana, Inc.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-98-13 through -15 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-16 through -18

Clearsky Shipping Company
c/o COSCO H.K. Shipping Company Ltd.
Attn: Mr. F. Y. Khong
167 Connaught Road West
Hong Kong

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

The National Transportation Safety Board determined that the probable cause of this accident was the failure of Clearsky Shipping Company to adequately manage and oversee the maintenance of the engineering plant aboard the *Bright Field*, with the result that the vessel temporarily lost power while navigating a high-risk area of the Mississippi River. Contributing to the amount of property damage and the number and types of injuries sustained during the accident was the failure of the U.S. Coast Guard, the Board of Commissioners of the Port of New Orleans, and International RiverCenter, Inc., to adequately assess, manage, or mitigate the risks associated with locating unprotected commercial enterprises in areas vulnerable to vessel strikes.

Safety Board investigators' examination of the engineering plant and maintenance records for the *Bright Field* revealed engine lubricating oil that was not within the allowable specifications of the oil supplier or engine designer, excessive differential pressure across the second oil filter, and uncorrected vibration and noise from both main engine lubricating oil pumps. Among other deficiencies identified were marginal lubricating oil sump level, incorrectly calibrated sensing devices, reuse of worn parts, and numerous other problems associated with the

[1] For more detailed information, read Marine Accident Report—*Allision of the Liberian Freighter* Bright Field *with the Poydras Street Wharf, Riverwalk Marketplace, and New Orleans Hilton Hotel in New Orleans, Louisiana, December 14, 1996.* (NTSB/MAR-98/01).

main engine and various auxiliary systems/machinery. While many deficiencies were corrected before the December 14 voyage, the vessel sailed with several significant engineering problems uncorrected.

A review of the vessel's records dating back to January 1996 revealed that the engineering crew responded to recurring engineering failures with repairs that were sufficient to keep the vessel operating most of the time. However, the crew apparently was not able to make permanent repairs to the vessel's main engine and associated engineering systems; as a result, these problems became a continuing source of voyage disruptions. In the 3 months prior to the accident, the *Bright Field* added about 1 month to its schedule due to delays attributed to engineering problems.

The crew was not required to use the automated propulsion control test procedures that were delivered with the vessel in 1988 or to periodically test the functional operability of the automated propulsion control system. The engineering plant on the *Bright Field* was equipped with a number of safety devices, and the chief electrician submitted a report concerning the status of these devices to the vessel's owners quarterly. But the report was based only on a survey of alarms and sensors. No one regularly performed operational testing and maintenance of safety control devices such as the oil pressure switch that was supposed to start the standby oil pump in case of a drop in main engine lubricating oil pressure.

While the *Bright Field*'s owners provided each vessel in their fleet with general requirements for periodic testing and maintenance of the main engine, including regular analysis of the main engine lubricating oil, Safety Board investigators determined that critical main engine components were run until failure occurred and that periodic preventive maintenance was not routinely accomplished.

The Safety Board concluded that the *Bright Field* showed evidence of recurring engineering problems that affected vessel main engine reliability, and had all engineering systems been kept in good repair and regularly tested, the vessel may not have unexpectedly lost power during its voyage down the Mississippi River.

Clearsky Shipping Company received regular engineering and maintenance reports on the *Bright Field* and thus had knowledge of the vessel's engineering problems. Serious engineering problems were reported to Clearsky as early as January 1996. In addition to reports from the engineering crew, the owners had received periodic telexes from the master documenting the severity of engineering problems, delays in scheduling resulting from the engineering problems, and the inability of the engineering crew to make permanent repairs. On at least one occasion in 1996, the *Bright Field's* owners' representatives visited the vessel because of concerns about the operation of the engineering plant. The Safety Board acknowledges that the owners did replace the *Bright Field*'s chief engineer when the vessel arrived in New Orleans on November 21 because, they said, the engineer had been unresponsive to the owners' orders. The documented problems with the *Bright Field*'s engineering plant, however, existed at least as early as 1995, which predated the arrival on board of the previous chief engineer. These engineering deficiencies are indicative of long-term, recurring problems that cannot be tied to the competence or job performance of a single individual.

The Safety Board concluded that the *Bright Field* owners' oversight of testing and maintenance of the vessel's engineering systems was inadequate and led to unreliable performance of the engineering plant and contributed to the shutdown of the main propulsion engine on the day of the accident.

Quite by chance, the *Bright Field* came to rest between two docked ships in a spot not significantly larger than the ship itself. While the actions of the pilot and crew during the emergency may have been reasonable, their actions were not well-coordinated. Because a computer simulation of the accident scenario was inconclusive, the Safety Board could not determine how changes in the nature or timing of the crew's actions may have affected the outcome. The Safety Board concluded, however, that at several points prior to and during the *Bright Field* emergency, the pilot, master, and crew of the vessel did not exchange information that under other circumstances could have prevented or at least mitigated the effects of the accident.

In the view of the Safety Board, the performance of the *Bright Field* pilot and crew could have benefited from effective application of the principles of bridge resource management (BRM), which entails effective use of all available resources to achieve safe operations. Underlying effective BRM is an understanding that every officer, crewmember, and pilot on board a vessel is responsible for acting and for using resources in close coordination with others on the watch. The master, pilot, and conning officer use leadership skills and command authority to integrate the resources for any given passage or watch. At the same time, they must convey their receptivity to operating information that originates with subordinates. The role of those on the watch is to perform their assigned tasks responsibly, to know about or participate in determining the plans for navigation of the vessel, to be alert to departures from plans or from the expected performance of others, and to make those discrepancies known in time to avert an operational error.

The pilot of the *Bright Field* did not advise the master of his plans for making the river transit, including the fact that he intended to operate the ship at sea speed. Had the pilot offered, or had the master requested, information on the transit plans, not only would both men, as well as the bridge crew, have known when and where to expect various actions, but the flow of information could have enhanced coordination and confidence between the pilot, master, and crew. If, for example, the master had asked, or the pilot had offered, information on the pilot's intended transit speed, that issue could have been discussed, and together they could have evaluated the operational consequences of proceeding at sea speed. Navigational situations can develop at any time for which an increase in speed (to improve rudder control or avoid collision) is a viable option, but, when a ship is already operating at top speed, that option is no longer available. If the pilot and master had discussed the intended speed, they could have reached a consensus on the best way to operate.

A transit plan should include intended speeds, areas of high risk due to traffic concentration, shoreside structures, or river flow characteristics, and actions to be taken in the event of various ship power or control difficulties. According to their statements, each man felt confident of his own abilities and assumed that the other was qualified to perform any duties that

might be required. The lack of discussions between the master and pilot regarding emergency maneuvering procedures did not cause this accident. Still, if the actions to be taken in an emergency had been established, cooperation and coordination in the emergency that developed would probably have been enhanced, tasks could have been clearly delineated, and orders (such as the order to drop anchor) could perhaps have been given and complied with more quickly.

While the pilot was not forthcoming with information about his transit plans, the master did not tell the pilot of the inability to start the main engine from the bridge either at 1055 or when the same difficulty was encountered at 1110. In each case, engine control had to be transferred to the engine control room and back, but this information was not made known to the pilot. Had the pilot been made aware of the situation, he and the master could have discussed options, including the location of engine control (control room or wheelhouse) or use of tug escorts. If the pilot and master could not agree, the pilot could have refused to get underway from the anchorage.

If more information had been exchanged during the 3 minutes after power reduction and before the allision, the actions of the pilot and crew could have been better coordinated and perhaps more timely. Even though the eventual outcome would probably have been the same in this case, in different circumstances, more effective communication could have helped avoid or mitigate an accident.

A limited information exchange took place among the master, second mate, and chief engineer. The master instructed the second mate to call the engine control room and demand an immediate increase in speed. The second mate complied. In response, the chief engineer said he understood what had happened (a sudden drop in the pressure of the lubricating oil pump), but not why it happened, and told the second mate so. He also told the second mate the pressurization problem had already been solved by the No. 2 pump coming on line. He then asked if the second mate wanted to switch engine control from the bridge to the engine control room. The second mate said yes, and the transfer of control began.

In this case, since the pressurization problem had already been corrected, the rpm could have been restored from the bridge as quickly as from the engineroom. If that had been done, the transfer time could have been saved. However, the second mate apparently did not recognize the implication of the chief engineer's comment, which was that the second engineer could increase rpm himself. So when the chief engineer asked for engine control to be transferred, the second mate agreed. The second mate was quite likely simply following the master's order to have "them" (the chief engineer and his staff) increase speed. If the chief engineer had supplied information to the bridge about the time necessary for him to assume control and restore engine rpm, this information may have altered the nature and timing of the master's and pilot's orders.

The second mate also did not immediately pass on the information about the lubricating oil repressurization to the master. If he had, the master may have recognized his option to increase rpm from the bridge and may not have followed the normal practice of sending engine-related problems to the engine control room, thereby saving the control transfer time. Likewise, if the second mate had given the chief engineer additional information about the direction in which the ship was headed, the chief engineer could have made a more informed decision

concerning the options for increasing rpm, such as activating the crash maneuvering feature or perhaps not transferring engine control to the engine control room. After the accident, the master testified that the engineering crew was not made aware of the emergency situation until the allision was unavoidable.

Had the above additional information been supplied during these exchanges, it may not have altered the outcome. Nevertheless, additional information should have been exchanged to facilitate decisions.

As a result of its investigation of the *Bright Field* accident, the National Transportation Safety Board makes the following safety recommendations to Clearsky Shipping Company:

> Perform a baseline engineering assessment of the *Bright Field*'s engineering plant and correct all conditions not in conformance with manufacturer's specifications. (M-98-16)
>
> Institute an engineering testing, maintenance, repair, and company oversight program for the *Bright Field* that will ensure safe and reliable operation of the vessel's engineering plant. (M-98-17)
>
> Provide your bridge and engineroom watchstanding officers and crewmembers with initial and recurrent bridge resource management training that includes communication and coordination between pilots and members of the bridge and engineroom watches and that addresses their use of bridge and engineroom systems. (M-98-18)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-7 and -8 to the State of Louisiana; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-13 through -15 to International RiverCenter; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots Association; M-98-27 and -28 to the Crescent River Port Pilots Association; and M-98-29 and -30 to the Associated Federal Pilots and Docking Masters of Louisiana, Inc.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-98-16 through -18 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-19 through -23

Mr. Warren L. Ruther, Jr.
Chief Executive Officer
New Orleans Paddlewheels, Inc.
690 Port of New Orleans Place
New Orleans, Louisiana 70130

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

Questionnaires were sent to 74 persons who had been either in or near the Riverwalk Marketplace when the accident occurred or who were among the passengers and crew of the *Queen of New Orleans* or *Creole Queen* at the time of the allision. A total of 12 responses were received from individuals who said they had been aboard the *Queen of New Orleans* when the *Bright Field* struck the wharf.

According to the *Queen of New Orleans' Emergency Evacuation Plan for Moored Conditions*, the vessel can be exited only from the bow section of the second deck. The plan states that to evacuate the vessel in an emergency, every passenger is to be directed to this gangway. The owner of the vessel noted that three portable emergency gangways, which are designed to be used in the event the main gangway is inoperable, are aboard the vessel. The vessel's emergency evacuation plan, however, does not refer to these portable gangways, or provide instructions on how to make them operable in an emergency, or give guidance for directing passengers to them. The evacuation plan also does not take into account the time needed to alert the crew to take action or for crewmembers to stage the portable gangways and

[1] For more detailed information, read Marine Accident Report—*Allision of the Liberian Freighter* Bright Field *with the Poydras Street Wharf, Riverwalk Marketplace, and New Orleans Hilton Hotel in New Orleans, Louisiana, December 14, 1996.* (NTSB/MAR-98/01).

assure their safe operation. Because the emergency gangways were not used during the *Bright Field* accident, the only exit available was the second deck bow gangway.

New Orleans Paddlewheels, Inc., provided security camera videotapes that show areas of the vessel being evacuated in what company officials call "a calm and orderly evacuation." The Safety Board did not see, on these tapes, any passengers sustaining injuries during the evacuation. Nonetheless, some passengers were injured, as documented by medical records. While the Safety Board recognizes that the number of questionnaire responses was small relative to the number of passengers aboard the vessel, the responses are nevertheless meaningful and illustrate the panic induced when the crowd was confronted with no means of escape from a vessel directly threatened by an oncoming freighter. Furthermore, had the vessel been filled to its capacity of 1,800 passengers and crewmembers, the number of persons unable to evacuate in time could have been significantly higher. The ensuing panic most likely would have been more hazardous, possibly resulting in a higher number of, and more severe, injuries. The Safety Board concluded that evacuation of the *Queen of New Orleans* was hampered, and passenger risk increased, by the fact that only one gangway was made available for passenger egress during the emergency.

The *Creole Queen*, a New Orleans Paddlewheels, Inc., excursion vessel with a capacity of 1,000 passengers and crew, was docked astern of the *Queen of New Orleans*. At the time of the accident, 190 passengers and crewmembers were aboard. Following the master's instructions to evacuate, passengers exited the vessel across a single dockside gangway. When the bow wave from the *Bright Field* passed the *Creole Queen*, the gangway dropped from the side of the vessel, and three passengers on the gangway fell into the river. One passenger was seriously injured; the other two sustained minor injuries. By this time, approximately one half of the *Creole Queen*'s passengers had been evacuated. The remaining passengers could not exit the vessel until the gangway was repositioned.

The Safety Board acknowledges the efforts of the senior officers of both vessels to evacuate a large number of passengers. Even so, if the 36,000-ton *Bright Field* had struck the *Queen of New Orleans*, the remaining passengers still on board the gaming vessel, regardless of their exact numbers, would have been in grave danger.

The Safety Board concluded that New Orleans Paddlewheels, Inc., must make better provisions for all its vessels in the event of an impending allision or other emergency. Consequently, the Safety Board issued the following safety recommendations to New Orleans Paddlewheels, Inc., on September 5, 1997:

> Work with the U.S. Coast Guard to review the *Emergency Evacuation Plan for Moored Conditions* of the *Queen of New Orleans* and amend it regarding current evacuation procedures and the number of immediately accessible gangways and disembarkation locations, to ensure timely and orderly exiting of passengers in the event of emergency evacuation. (M-97-62)
>
> Work with the U.S. Coast Guard to develop and implement procedures for evacuation under moored or docked conditions for all your excursion vessels to

> ensure that passengers can exit each vessel in a timely and orderly manner should an emergency evacuation be necessary. (M-97-63)

In a September 29, 1997, letter to the Safety Board, New Orleans Paddlewheels, Inc., replied that its emergency evacuation plan for the *Queen of New Orleans* in moored conditions

> addresses the evacuation of all areas on board the vessel. We purposely did not include portable gangways because they are to be used only when the primary evacuation gangway is inoperable. Our deck crew is regularly trained and drilled on how to use these portable gangways in multiple locations.

The Safety Board is concerned that the evacuation plan for the *Queen of New Orleans* does not provide a readily available additional means of escape that does not require staging in an emergency. The Safety Board's intent in issuing Safety Recommendation M-97-62 was to prompt New Orleans Paddlewheels, Inc., to amend the *Queen of New Orleans*'s *Evacuation Plan for Moored Conditions* not only to enhance evacuation procedures, but also to address the need to provide for more than one immediately accessible disembarkation location to ensure a timely and orderly exiting of passengers.

Further, although the September 29 letter states that the deck crew is trained and drilled on use of the portable gangways, the letter does not address the training of the nonoperating crewmembers, who are responsible for assisting passengers to the egress areas of the vessel during emergencies. The *Evacuation Plan for Moored Conditions* provides no guidance on the use of portable gangways to the numerous nonoperating crew on board the vessel who are responsible for directing passengers and assisting their escape. Moreover, the specific plan to which all crewmembers are to look for guidance in responding to emergency situations does not provide any information on these gangways or how to guide passengers to them. Based on the failure of New Orleans Paddlewheels, Inc., to effectively address these concerns, the Safety Board classifies Safety Recommendation M-97-62 "Closed--Unacceptable Action." New Orleans Paddlewheels, Inc., has not responded to Safety Recommendation M-97-63 concerning the development of evacuation procedures for moored or docked conditions for all its excursion vessels. Therefore, Safety Recommendation M-97-63 remains classified "Open--Await Response."

All of the surveyed passengers from the *Queen of New Orleans* said they had boarded the vessel between 1300 and 1400. Nine of the passengers did not recall receiving any information concerning what to do in the event of an emergency and did not recall observing any safety information placards when they boarded the vessel. Seven of these passengers did not receive a life jacket when evacuating the vessel. Each of these passengers recalled first learning about the emergency when they heard the announcement from the first mate over the public address system.

The company operating manuals and station bills for both the *Queen of New Orleans* and *Creole Queen* clearly stated that nonoperating crewmembers were responsible for distributing life jackets, keeping order in the stairways and passageways, and controlling the movement of passengers to ensure their safety. During the *Bright Field* emergency, however, several

nonoperating crewmembers experienced difficulty in performing their duties. For example, when the first mate directed the crewmembers to go to their mooring stations during the evacuation of the *Queen of New Orleans*, the vessel's director of security did not understand or appreciate the implications of this announcement. Also, nonoperating crewmembers did not distribute life jackets to passengers aboard the *Creole Queen* during the emergency.

Drills held aboard the *Queen of New Orleans* had not simulated an evacuation while moored. Moreover, the drills and training sessions that were held only involved supervisory gaming staff, who were expected to inform other gaming staff crewmembers of their content. No formal methods were used to verify whether the nonoperating crewmembers were advised of the content of the safety meetings or the nature of drills performed. Unless it requires accountability for the flow of safety information from supervisory gaming staff to the rest of the nonoperating staff, management cannot ensure that the latter receive safety information that could be critical in an emergency. The Safety Board concluded that nonoperating crewmembers of the *Queen of New Orleans* and the *Creole Queen* had not received training covering the full range of emergency scenarios and were unprepared to properly carry out their responsibilities in this accident.

As a result of its investigation of a 1994 fire aboard the small passenger vessel *Argo Commodore*,[2] the Safety Board issued the following recommendation to the Passenger Vessel Association (PVA):

> Develop and provide to your members crew drills for on-board crew emergency procedures/standards that include preincident planning for a variety of shipboard emergencies, including fires, and the deployment of crew resources for proper response to the emergency without compromising passenger safety. (M-95-43)

This recommendation was later placed on the Safety Board's list of Most Wanted Safety Improvements. In 1997, the PVA made available to the Safety Board its recently published *Training Manual for Passenger Vessel Safety*, which incorporates a "Non-marine Crew Training" section that outlines a comprehensive training program for nonoperating crewmembers. The introduction to this section states that specialized safety training for nonoperating employees "makes sense when management realizes that, more often than not, [these employees] will be the first person[s] on the scene in any kind of emergency."

Based on the PVA's support for the concept of comprehensive training for nonoperating employees and its development of the training manual, the Safety Board classified Safety Recommendation M-95-43 "Closed--Acceptable Action." The Safety Board notes that New Orleans Paddlewheels, Inc., which is a PVA member, has apparently not yet implemented the training program for nonoperating crewmembers set forth by the PVA in its training manual.

According to the vessel master, when the *Queen of New Orleans* was to remain moored, he did not make any safety announcements because he believed the vessel was an extension of

[2]Marine Accident Report--*Fire Aboard U.S. Small Passenger Vessel* Argo Commodore *in San Francisco Bay, California, December 3, 1994* (NTSB/MAR-95/03).

the dock when not underway. The *Queen of New Orleans* broadcast a vessel safety videotape throughout the vessel's queuing area; however, a significant number of passengers on board the vessel on the day of the accident, some of whom had been on the vessel several times before, did not recall ever having seen or heard the safety broadcast. Because the scheduled cruise had been canceled because of the high river stage, no safety briefings were provided prior to the *Bright Field* accident. However, the master stated that he had instructed the engineer to start the engines to prepare for leaving the dock to avoid being struck by the *Bright Field*. Had the vessel left the dock, the master probably would not have had time to provide passengers with such basic instructions as the location of life jackets. The Safety Board concluded that the lack of effective recurring safety briefings for occupants of the *Queen of New Orleans* regarding emergency and evacuation procedures may have contributed to the confusion and panic reported among passengers and crew during the vessel evacuation.

Emergency instruction placards and signage aboard the *Queen of New Orleans* were not conspicuously displayed and were not readily visible during the emergency. The safety instructions, printed on plain white paper with clear laminate, were subject to destruction in an emergency such as that involving fire. Moreover, the paper on which the instructions were printed was similar to the color of the walls upon which they were affixed, negating their effectiveness in an emergency characterized by haste, panic, or reduced visibility. According to a number of the vessel's passengers on the day of the accident, they did not see emergency instruction signage or egress diagrams. The Safety Board concluded that the instruction placards and signage aboard the *Queen of New Orleans* were ineffective in disseminating emergency instructions and vessel information to passengers.

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Board of Commissioners of the Port of New Orleans (the "Dock Board"), the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the Dock Board, had commissioned partial risk assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field*.

For example, risk assessment projects predicted an increase in accidents involving collisions, rammings, and groundings due to increased river traffic. The Louisiana State University risk assessment project, in 1994, concluded that no sections of the Port of New Orleans waterfront were free of ship allisions, including the area where the high-capacity passenger vessels, gaming vessels, and riverfront properties were located. Analysis of accident data for the Port of New Orleans from 1983 through 1993 (a total of 166 rammings along the left descending bank between miles 91 and 101 AHP) identified a mooring area for gaming vessels that had seen the fewest "historical allisions on the left bank." The study acknowledged, however, that no area of the left descending bank of the river had been completely free of vessel strikes during the 11-year period studied.

Several passenger vessels, including gaming, tour and cruise vessels, were allowed to dock along the left descending bank, the side of the river at highest risk. Had the *Bright Field* lost power some time later and the same accident scenario evolved, the ship would likely have rammed the gambling vessel, resulting in substantial loss of life. The cruise vessels, which had even less warning time, would quite likely also have sustained serious passenger injuries or loss of life.

While silting around the vessels' docking areas may offer some protection from ramming by deep-draft vessels at average river stages, the silt layer did not reduce water depth sufficiently to retard a runaway ship when the river was high, as it was on the day of the *Bright Field* accident. The property owners and other stakeholders within the Port of New Orleans clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded that the Coast Guard, the Dock Board, and the property owners did not adequately address the risks posed to moored vessels along the Erato, Julia, Poydras, and Canal Street wharves; as a result, under certain conditions, those vessels were vulnerable to ramming by other marine traffic.

The Coast Guard has overall responsibility for maintaining public safety in the Port of New Orleans area. Under the *Ports and Waterways Safety Act of 1972*, the Congress charged the Coast Guard with monitoring and managing risk in all U.S. ports and taking actions to maintain risk at an acceptable level. In carrying out this role, the Coast Guard must assess and manage the risk that is inherent in all commercial activities within U.S. ports. In fact, in its *1996 Performance Report*, the Coast Guard's Office of Marine Safety and Environmental Protection asserts that managing risk is its primary mission. The Safety Board concurs with this assessment and notes that the Coast Guard has the authority, the responsibility, and the experience to direct a comprehensive assessment of risk in the Port of New Orleans.

As a result of its investigation of the *Bright Field* accident, the National Transportation Safety Board makes the following safety recommendations to New Orleans Paddlewheel, Inc.:

> In accordance with the guidance published by the Passenger Vessel Association, require that nonoperating crewmembers on all your vessels participate in formal emergency training and drills in the proper handling of emergencies that have the potential to affect the persons in their charge. Maintain written records to verify nonoperating crew proficiency levels and skill retention. (M-98-19)
>
> Review the existing methods of providing safety information to boarding passengers and make the necessary improvements to ensure that all vessel occupants receive recurring safety briefings, regardless of whether the vessel is scheduled to leave the dock. (M-98-20)
>
> On all your vessels, post emergency instructions that are printed on fire- and heat-resistant material and that are clearly visible to all passengers both under normal conditions and during emergencies when lighting and visibility may be diminished. (M-98-21)

Participate with the U.S. Coast Guard and other stakeholders in a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-22)

In cooperation with the U.S. Coast Guard and other stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that will ensure the safety of people and property within the Port of New Orleans. (M-98-23)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-7 and -8 to the State of Louisiana; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-98-13 through -15 to International RiverCenter; M-98-16 through -18 to Clearsky Shipping Company; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots Association; M-98-27 and -28 to the Crescent River Port Pilots Association; and M-98-29 and -30 to Associated Federal Pilots and Docking Masters of Louisiana, Inc.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-98-19 through -23 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-24 through -26

Captain C. E. Clayton
President
New Orleans Baton Rouge Steamship Pilots Association
3900 River Road, Suite 7
Jefferson, Louisiana 70121

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Board of Commissioners of the Port of New Orleans (the "Dock Board"), the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the Dock Board, had commissioned partial risk assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field*.

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data for the Port of New Orleans from 1983 through 1993 (a total of 166 rammings along the left descending bank between miles 91 and 101 AHP) identified a mooring area for gaming vessels that had seen the fewest "historical allisions on the left bank." The study acknowledged, however, that no area of the left descending bank of the river had been completely free of vessel strikes during the 11-year period studied.

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While silting around the vessels' docking areas may offer some protection from ramming by deep-draft vessels at average river stages, the silt layer did not reduce water depth sufficiently to retard a runaway ship when the river was high, as it was on the day of the *Bright Field* accident. The property owners and other stakeholders within the Port of New Orleans clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded that the Coast Guard, the Dock Board, and the property owners did not adequately address the risks posed to moored vessels along the Erato, Julia, Poydras, and Canal Street wharves; as a result, under certain conditions, those vessels were vulnerable to ramming by other marine traffic.

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Among the factors that must be considered are risks associated with relatively high-speed navigation of the river, high river stage and rapid river current, railroad and highway bridges spanning the waterway, and the carriage of cargoes such as bulk oil or other hazardous materials or chemicals that can cause pollution, fire, or explosion. The Safety Board notes that many of the risk factors associated with river commerce within the port area have already been identified in previous risk-assessment studies and, further, that these factors may be amenable to known risk-reduction or risk-mitigation initiatives. Such initiatives might include reducing vessel speed, opening the Bonnet Carré Spillway on a more regular basis, using tugboats either as escorts or as a "barrier" to protect marine assets, adequately assessing the protection afforded by silting-in of vulnerable areas, and moving the passenger vessels to a safer location.

At the time the vessel lost propulsion, the *Bright Field* was operating at full speed in high-river and high-current conditions. In his testimony, the pilot claimed that it was necessary to

operate the *Bright Field* at maximum speed to attain reasonable maneuverability of the vessel in the operating environment of high water, rapid current, and a heavily laden ship designed to be maneuverable at lower speeds.

Several days after the accident, Safety Board investigators boarded a fully loaded vessel of similar size, displacement, and power to the *Bright Field* that was operating downbound in similar high water conditions. During this transit, the pilot did not use full speed to maneuver the ship. Each ship handles differently, but the operation of the *Bright Field* at full speed left no margin for error. For example, the main engine tripped off line because of a temporary loss of lubricating oil pressure. The oil pressure and engine operation were restored within about 2 minutes, which is a reasonable amount of time. However, operating at full speed in high-river conditions, the ship had no room to maneuver out of the emergency. The Safety Board concluded that operating a vessel at full speed in the restricted waters of the Mississippi River may not allow sufficient time or distance to recover from an emergency. The Safety Board is recommending that the Coast Guard take the lead in working with the pilot associations serving the Port of New Orleans to evaluate the impact of operating vessels at full speed in the Mississippi River and incorporate that information in its risk-management and risk-reduction strategies for the port area.

No practical physical barrier aboard ship exists that will safely stop a runaway vessel. In such an emergency, a safe outcome depends on the successful interaction of several physical and operational factors. For example, if main engine power is lost, adequate steering can usually be maintained until the ship slows enough for the anchors to be dropped. If a vessel loses its steering, engine power can be used to either slow the vessel (astern power) or, if it is a twin-screw vessel, to maneuver the ship.

Anchors are perceived as providing some level of protection by serving as "brakes" that will stop or at least slow a ship. But anchors are neither designed nor adequate for stopping a heavily loaded ship traveling at high speed. Had the *Bright Field*'s anchors been released, the anchor chain would quite likely have payed out at a speed that could not be controlled by the windlass brake, and the chain would simply have continued to run out until it parted from the ship. In this accident, the dropping of the anchor and paying out of chain could not have been expected to significantly slow, let alone stop, the ship.

Since this accident, the Coast Guard has placed renewed emphasis on having anchors at the ready (backed out of the hawsepipe, disengaged from the windlass, and being held by the brake), with a two-person forecastle watch. While having the anchors manned and at the ready may prove beneficial in certain circumstances, it is unlikely to achieve anything meaningful aboard a heavy vessel operating at relatively high speeds in the Mississippi River. Further, "increased emphasis" on having the anchors at the ready may even provide a false sense of security without effectively addressing the dangers inherent in operating heavy vessels at high speed in proximity to shoreside businesses and other marine traffic.

Quite by chance, the *Bright Field* came to rest between two docked ships in a spot not significantly larger than the ship itself. While the actions of the pilot and crew during the emergency may have been reasonable, their actions were not well-coordinated. Because a

computer simulation of the accident scenario was inconclusive, the Safety Board could not determine how changes in the nature or timing of the crew's actions may have affected the outcome. The Safety Board therefore concludes that insufficient information was available to determine whether any actions taken by the pilot and crew of the *Bright Field* would have been effective in preventing the allision or mitigating its effects. The Safety Board also concludes, however, that at several points prior to and during the *Bright Field* emergency, the pilot, master, and crew of the vessel did not exchange information that under other circumstances could have prevented or at least mitigated the effects of the accident.

In the view of the Safety Board, the performance of the *Bright Field* pilot and crew could have benefited from effective application of the principles of bridge resource management (BRM), which entails effective use of all available resources to achieve safe operations. The Safety Board has long supported mariners' use of BRM techniques and has advocated professional training in BRM.

Underlying effective BRM is an understanding that every officer, crewmember, and pilot on board a vessel is responsible for acting and for using resources in close coordination with others on the watch. The master, pilot, and conning officer use leadership skills and command authority to integrate the resources for any given passage or watch. At the same time, they must convey their receptivity to operating information that originates with subordinates. The role of those on the watch is to perform their assigned tasks responsibly, to know about or participate in determining the plans for navigation of the vessel, to be alert to departures from plans or from the expected performance of others, and to make those discrepancies known in time to avert an operational error. The practice of BRM by pilots and crew can be handicapped by intercultural or language differences, but these can often be overcome by deliberate and clear master/pilot/crew briefings.

The pilot of the *Bright Field* did not advise the master of his plans for making the river transit, including the fact that he intended to operate the ship at sea speed. Had the pilot offered, or had the master requested, information on the transit plans, not only would both men, as well as the bridge crew, have known when and where to expect various actions, but the flow of information could have enhanced coordination and confidence between the pilot, master, and crew.

If, for example, the master had asked, or the pilot had offered, information on the pilot's intended transit speed, that issue could have been discussed, and together they could have evaluated the operational consequences of proceeding at sea speed. Navigational situations can develop at any time for which an increase in speed (to improve rudder control or avoid collision) is a viable option, but, when a ship is already operating at top speed, that option is no longer available. If the pilot and master had discussed the intended speed, they could have reached a consensus on the best way to operate.

Although a discussion of intended actions can take place at any time during a transit, predeparture discussions generally provide the greatest latitude in both time and options. A predeparture discussion also avoids some of the practical logistical problems (related to obtaining another pilot) that could arise if a serious disagreement occurs between a master and a pilot once

a trip begins. Thus, discussing and agreeing on transit plans before getting underway is more efficient.

A transit plan should include intended speeds, areas of high risk due to traffic concentration, shoreside structures, or river flow characteristics, and actions to be taken in the event of various ship power or control difficulties. According to their statements, each man felt confident of his own abilities and assumed that the other was qualified to perform any duties that might be required. The lack of discussions between the master and pilot regarding emergency maneuvering procedures did not cause this accident. Still, if the actions to be taken in an emergency had been established, cooperation and coordination in the emergency that developed would probably have been enhanced, tasks could have been clearly delineated, and orders (such as the order to drop anchor) could perhaps have been given and complied with more quickly.

While the pilot was not forthcoming with information about his transit plans, the master did not tell the pilot of the inability to start the main engine from the bridge either at 1055 or when the same difficulty was encountered at 1110. In each case, engine control had to be transferred to the engine control room and back, but this information was not made known to the pilot. Had the pilot been made aware of the situation, he and the master could have discussed options, including the location of engine control (control room or wheelhouse) or use of tug escorts. If the pilot and master could not agree, the pilot could have refused to get underway from the anchorage.

If more information had been exchanged during the 3 minutes after power reduction and before the allision, the actions of the pilot and crew could have been better coordinated and perhaps more timely. Even though the eventual outcome would probably have been the same in this case, in different circumstances, more effective communication could have helped avoid or mitigate an accident.

When the pilot noticed the cessation of vibration in the vessel, he asked if there was a problem. Even though he stated that neither the master nor the mate responded, he did not ask a second time. By not following up and attempting to determine the exact nature of the problem, the pilot denied himself information that may have influenced the nature or the timing of his navigational decisions and orders.

When the pilot realized that the vessel had, in fact, lost power, he again did not converse with the master or mate. Consequently, he was unaware of what they were doing or could do to address the problem. Although the master and the mate were attempting to restore engine rpm, they did not tell the pilot of their actions.

Another information exchange between the pilot and master affected the order to drop anchor(s). During the accident sequence, the pilot first ordered the master to have someone stand by the anchors and, later, to drop the anchors. The orders were heard and understood by the master, though the pilot was unaware of that because the master did not acknowledge either order. The master attempted to carry out the order to drop anchor, but his radio communications with the carpenter at the bow were impeded by the sound of the ship's whistle. The master did not tell the pilot of the communication problem created by the whistle; instead, he went out to the

bridge wing and tried to attract the carpenter's attention by waving his arms. When this effort failed, the master tried the radio again, finally establishing intermittent contact. He still did not tell the pilot of his difficulties.

In the meantime, the pilot did not realize that he was preventing his own order from being carried out by continuing to sound the ship's whistle. Transmission of the order was delayed so long that when the master finally reached the carpenter on the radio, he deemed dropping the anchor to be an inappropriate order and countermanded it. By the time the master decided to drop the anchor, the carpenter could only make a brief effort to carry out the order before having to flee to escape injury in the imminent allision. As a result, and as confirmed by an amateur video of the accident, the anchor was not dropped before the *Bright Field* struck the wharf.

The fact that the pilot issued the order to drop anchor indicates that he believed that some value, however small, could be gained by dropping one or both anchors. Had he not believed that dropping anchors could mitigate the emergency, he was obligated to relay that information to the master so the carpenter could be told to abandon the anchor watch and remove himself to a safer position. Yet the pilot made no real effort to determine if his order had been carried out, even when he saw the master go to the bridge wing and wave his arms. If he did not recognize that effort as an attempt to communicate with the anchor watch, he should have inquired about the meaning of the master's unusual actions at such a critical time.

The lack of information exchange and feedback on the part of the master is also notable. For example, he did not tell the pilot that he had countermanded the drop-anchor order, only to reissue it a little later. Earlier in the accident sequence, he did not ensure that the pilot was fully aware of the actions he was taking to restore engine rpm. While the pilot could have inferred the master's actions from the rpm indicator, the master should have removed any ambiguity by advising the pilot of what he was doing at all times. Likewise the master could have given the pilot an estimate of the time it might take to restore engine power. If he did not know the amount of time needed, he could have asked the chief engineer. The pilot could have used each of these pieces of information as he determined which orders to issue at what time.

The need to exchange information and ensure that orders are heard, understood, and carried out is basic to the operation of any vessel. These needs are not new and are routinely carried out by mariners; however, they have in recent years been formalized as central elements of BRM. The Safety Board concludes that use of BRM precepts on board the *Bright Field* would have enhanced the exchange of information and the coordination of actions among the pilot, master, and crew during the accident sequence. The Safety Board has issued several recommendations concerning BRM since 1991. Due in part to those recommendations and the efforts of the Coast Guard, the International Maritime Organization (IMO) has issued amendments to its Standards of Training, Certification and Watchkeeping (STCW) that incorporate BRM training for watch officers effective February 1, 1997. Signatory countries are to have plans for such training programs in place by February 1, 1998. A 5-year phase-in period (from February 1, 1997) to certify licensed watch officers will follow. As signatory countries, the United States and Liberia (flag of the *Bright Field*) will require officers of vessels such as the

Bright Field to have BRM training. Pilots will not necessarily be subject to the same training unless they hold a Coast Guard license.

Training in BRM typically includes five generic categories of knowledge and skill development: (1) the development and performance of watch or pilot briefings; (2) maintenance of situational awareness; (3) identification of error chains (and error trapping); (4) implementation of effective bridge/vessel communication; and (5) integration (coordination) of bridge/vessel resources. In whole or in part, most of theses elements were missing during the *Bright Field*'s December 14, 1996, voyage.

The National Transportation therefore makes the following safety recommendation to the New Orleans Baton Rouge Steamship Pilots Association::

> Encourage your members to participate in initial and recurrent bridge resource management training that teaches the principles of resource management and that emphasizes team coordination between the pilot and crew. (M-98-24)
>
> Participate with the U.S. Coast Guard and other stakeholders in a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-25)
>
> In cooperation with the U.S. Coast Guard and other stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that will ensure the safety of people and property within the Port of New Orleans. (M-98-26)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-7 and -8 to the State of Louisiana; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-98-13 through -15 to International RiverCenter, Inc.; M-98-16 through -18 to Clearsky Shipping Company; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-27 and -28 to the Crescent River Port Pilots Association; and M-98-29 and -30 to Associated Federal Pilots and Docking Masters of Louisiana, Inc.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-98-24 through -26 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-27 and -28

Captain Mark Delesdernier
President
Crescent River Port Pilots Association
8712 Highway 23
belle Chasse, Louisiana 70037

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Board of Commissioners of the Port of New Orleans (the "Dock Board"), the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the Dock Board, had commissioned partial risk assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field.*

For example, risk assessment projects predicted an increase in accidents involving collisions, rammings, and groundings due to increased river traffic. The Louisiana State University risk assessment project, in 1994, concluded that no sections of the Port of New Orleans waterfront were free of ship allisions, including the area where the high-capacity passenger vessels, gaming vessels, and riverfront properties were located. Analysis of accident

[1]For more detailed information, read Marine Accident Report—*Allision of the Liberian Freighter* Bright Field *with the Poydras Street Wharf, Riverwalk Marketplace, and New Orleans Hilton Hotel in New Orleans, Louisiana, December 14, 1996.* (NTSB/MAR-98/01).

data for the Port of New Orleans from 1983 through 1993 (a total of 166 rammings along the left descending bank between miles 91 and 101 AHP) identified a mooring area for gaming vessels that had seen the fewest "historical allisions on the left bank." The study acknowledged, however, that no area of the left descending bank of the river had been completely free of vessel strikes during the 11-year period studied.

Several passenger vessels, including gaming, tour and cruise vessels, were allowed to dock along the left descending bank, the side of the river at highest risk. Had the *Bright Field* lost power some time later and the same accident scenario evolved, the ship would likely have rammed the gambling vessel, resulting in substantial loss of life. The cruise vessels, which had even less warning time, would quite likely also have sustained serious passenger injuries or loss of life.

While silting around the vessels' docking areas may offer some protection from ramming by deep-draft vessels at average river stages, the silt layer did not reduce water depth sufficiently to retard a runaway ship when the river was high, as it was on the day of the *Bright Field* accident. The property owners and other stakeholders within the Port of New Orleans clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded that the Coast Guard, the Dock Board, and the property owners did not adequately address the risks posed to moored vessels along the Erato, Julia, Poydras, and Canal Street wharves; as a result, under certain conditions, those vessels were vulnerable to ramming by other marine traffic.

The Coast Guard has overall responsibility for maintaining public safety in the Port of New Orleans area. Under the *Ports and Waterways Safety Act of 1972*, the Congress charged the Coast Guard with monitoring and managing risk in all U.S. ports and taking actions to maintain risk at an acceptable level. In carrying out this role, the Coast Guard must assess and manage the risk that is inherent in all commercial activities within U.S. ports. In fact, in its *1996 Performance Report*, the Coast Guard's Office of Marine Safety and Environmental Protection asserts that managing risk is its primary mission. The Safety Board concurs with this assessment and notes that the Coast Guard has the authority, the responsibility, and the experience to direct a comprehensive assessment of risk in the Port of New Orleans.

Among the factors that must be considered are risks associated with relatively high-speed navigation of the river, high river stage and rapid river current, railroad and highway bridges spanning the waterway, and the carriage of cargoes such as bulk oil or other hazardous materials or chemicals that can cause pollution, fire, or explosion. The Safety Board notes that many of the risk factors associated with river commerce within the port area have already been identified in previous risk-assessment studies and, further, that these factors may be amenable to known risk-reduction or risk-mitigation initiatives. Such initiatives might include reducing vessel speed, opening the Bonnet Carré Spillway on a more regular basis, using tugboats either as escorts or as a "barrier" to protect marine assets, adequately assessing the protection afforded by silting-in of vulnerable areas, and moving the passenger vessels to a safer location.

At the time the vessel lost propulsion, the *Bright Field* was operating at full speed in high-river and high-current conditions. In his testimony, the pilot claimed that it was necessary to

operate the *Bright Field* at maximum speed to attain reasonable maneuverability of the vessel in the operating environment of high water, rapid current, and a heavily laden ship designed to be maneuverable at lower speeds.

Several days after the accident, Safety Board investigators boarded a fully loaded vessel of similar size, displacement, and power to the *Bright Field* that was operating downbound in similar high water conditions. During this transit, the pilot did not use full speed to maneuver the ship. Each ship handles differently, but the operation of the *Bright Field* at full speed left no margin for error. For example, the main engine tripped off line because of a temporary loss of lubricating oil pressure. The oil pressure and engine operation were restored within about 2 minutes, which is a reasonable amount of time. However, operating at full speed in high-river conditions, the ship had no room to maneuver out of the emergency. The Safety Board concluded that operating a vessel at full speed in the restricted waters of the Mississippi River may not allow sufficient time or distance to recover from an emergency. The Safety Board is recommending that the Coast Guard take the lead in working with the pilot associations serving the Port of New Orleans to evaluate the impact of operating vessels at full speed in the Mississippi River and incorporate that information in its risk-management and risk-reduction strategies for the port area.

No practical physical barrier aboard ship exists that will safely stop a runaway vessel. In such an emergency, a safe outcome depends on the successful interaction of several physical and operational factors. For example, if main engine power is lost, adequate steering can usually be maintained until the ship slows enough for the anchors to be dropped. If a vessel loses its steering, engine power can be used to either slow the vessel (astern power) or, if it is a twin-screw vessel, to maneuver the ship.

Anchors are perceived as providing some level of protection by serving as "brakes" that will stop or at least slow a ship. But anchors are neither designed nor adequate for stopping a heavily loaded ship traveling at high speed. Had the *Bright Field*'s anchors been released, the anchor chain would quite likely have payed out at a speed that could not be controlled by the windlass brake, and the chain would simply have continued to run out until it parted from the ship. In this accident, the dropping of the anchor and paying out of chain could not have been expected to significantly slow, let alone stop, the ship.

Since this accident, the Coast Guard has placed renewed emphasis on having anchors at the ready (backed out of the hawsepipe, disengaged from the windlass, and being held by the brake), with a two-person forecastle watch. While having the anchors manned and at the ready may prove beneficial in certain circumstances, it is unlikely to achieve anything meaningful aboard a heavy vessel operating at relatively high speeds in the Mississippi River. Further, "increased emphasis" on having the anchors at the ready may even provide a false sense of security without effectively addressing the dangers inherent in operating heavy vessels at high speed in proximity to shoreside businesses and other marine traffic.

As a result of its investigation of the *Bright Field* accident, the National Transportation Safety Board makes the following safety recommendations to the Crescent River Port Pilots Association:

Participate with the U.S. Coast Guard and other stakeholders in a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-27)

In cooperation with the U.S. Coast Guard and other stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that will ensure the safety of people and property within the Port of New Orleans. (M-98-28)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-7 and -8 to the State of Louisiana; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-98-13 through -15 to International RiverCenter; M-98-16 through -18 to Clearsky Shipping Company; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots Association; and M-98-29 and -30 to Associated Federal Pilots and Docking Masters of Louisiana, Inc.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-98-27 and -28 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 6, 1998

In reply refer to: M-98-29 and -30

Captain Russell J. Belsome
President
Associated Federal Pilots and Docking Masters of Louisiana, Inc.
2315 N. Woodlawn Avenue
Suite 104
Metairie, Louisiana 70001

Shortly after 1400 on December 14, 1996, the fully loaded Liberian bulk carrier *Bright Field* temporarily lost propulsion power as the vessel was navigating outbound in the Lower Mississippi River at New Orleans, Louisiana. The vessel struck a wharf adjacent to a populated commercial area that included a shopping mall, a condominium parking garage, and a hotel. No fatalities resulted from the accident, and no one aboard the *Bright Field* was injured; however, 4 serious injuries and 58 minor injuries were sustained during evacuations of shore facilities, a gaming vessel, and an excursion vessel located near the impact area. Total property damages to the *Bright Field* and to shoreside facilities were estimated at about $20 million.[1]

This accident demonstrates that the many and diverse stakeholders in the area of the Port of New Orleans, including the Coast Guard, the State of Louisiana, the Board of Commissioners of the Port of New Orleans (the "Dock Board"), the pilot organizations, and the owners and operators of riverfront properties and nearby moored passenger ships, did not adequately prepare for or mitigate the risk of a marine casualty affecting people and property within the Port of New Orleans. Some of the stakeholders, most notably the Dock Board, had commissioned partial risk assessment studies at various times for the assets in the harbor area. Despite their limitations (in either geography or scope), these studies did provide adequate information for the stakeholders to recognize the possibility of an accident similar to the one involving the *Bright Field*.

For example, risk assessment projects predicted an increase in accidents involving collisions, rammings, and groundings due to increased river traffic. The Louisiana State University risk assessment project, in 1994, concluded that no sections of the Port of New Orleans waterfront were free of ship allisions, including the area where the high-capacity

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passenger vessels, gaming vessels, and riverfront properties were located. Analysis of accident data for the Port of New Orleans from 1983 through 1993 (a total of 166 rammings along the left descending bank between miles 91 and 101 AHP) identified a mooring area for gaming vessels that had seen the fewest "historical allisions on the left bank." The study acknowledged, however, that no area of the left descending bank of the river had been completely free of vessel strikes during the 11-year period studied.

Several passenger vessels, including gaming, tour and cruise vessels, were allowed to dock along the left descending bank, the side of the river at highest risk. Had the *Bright Field* lost power some time later and the same accident scenario evolved, the ship would likely have rammed the gambling vessel, resulting in substantial loss of life. The cruise vessels, which had even less warning time, would quite likely also have sustained serious passenger injuries or loss of life.

While silting around the vessels' docking areas may offer some protection from ramming by deep-draft vessels at average river stages, the silt layer did not reduce water depth sufficiently to retard a runaway ship when the river was high, as it was on the day of the *Bright Field* accident. The property owners and other stakeholders within the Port of New Orleans clearly had the responsibility to establish and maintain a reasonable level of safety in the port area. The Safety Board concluded that the Coast Guard, the Dock Board, and the property owners did not adequately address the risks posed to moored vessels along the Erato, Julia, Poydras, and Canal Street wharves; as a result, under certain conditions, those vessels were vulnerable to ramming by other marine traffic.

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Among the factors that must be considered are risks associated with relatively high-speed navigation of the river, high river stage and rapid river current, railroad and highway bridges spanning the waterway, and the carriage of cargoes such as bulk oil or other hazardous materials or chemicals that can cause pollution, fire, or explosion. The Safety Board notes that many of the risk factors associated with river commerce within the port area have already been identified in previous risk-assessment studies and, further, that these factors may be amenable to known risk-reduction or risk-mitigation initiatives. Such initiatives might include reducing vessel speed, opening the Bonnet Carré Spillway on a more regular basis, using tugboats either as escorts or as a "barrier" to protect marine assets, adequately assessing the protection afforded by silting-in of vulnerable areas, and moving the passenger vessels to a safer location.

At the time the vessel lost propulsion, the *Bright Field* was operating at full speed in high-river and high-current conditions. In his testimony, the pilot claimed that it was necessary to operate the *Bright Field* at maximum speed to attain reasonable maneuverability of the vessel in the operating environment of high water, rapid current, and a heavily laden ship designed to be maneuverable at lower speeds.

Several days after the accident, Safety Board investigators boarded a fully loaded vessel of similar size, displacement, and power to the *Bright Field* that was operating downbound in similar high water conditions. During this transit, the pilot did not use full speed to maneuver the ship. Each ship handles differently, but the operation of the *Bright Field* at full speed left no margin for error. For example, the main engine tripped off line because of a temporary loss of lubricating oil pressure. The oil pressure and engine operation were restored within about 2 minutes, which is a reasonable amount of time. However, operating at full speed in high-river conditions, the ship had no room to maneuver out of the emergency. The Safety Board concluded that operating a vessel at full speed in the restricted waters of the Mississippi River may not allow sufficient time or distance to recover from an emergency. The Safety Board is recommending that the Coast Guard take the lead in working with the pilot associations serving the Port of New Orleans to evaluate the impact of operating vessels at full speed in the Mississippi River and incorporate that information in its risk-management and risk-reduction strategies for the port area.

No practical physical barrier aboard ship exists that will safely stop a runaway vessel. In such an emergency, a safe outcome depends on the successful interaction of several physical and operational factors. For example, if main engine power is lost, adequate steering can usually be maintained until the ship slows enough for the anchors to be dropped. If a vessel loses its steering, engine power can be used to either slow the vessel (astern power) or, if it is a twin-screw vessel, to maneuver the ship.

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Since this accident, the Coast Guard has placed renewed emphasis on having anchors at the ready (backed out of the hawsepipe, disengaged from the windlass, and being held by the brake), with a two-person forecastle watch. While having the anchors manned and at the ready may prove beneficial in certain circumstances, it is unlikely to achieve anything meaningful aboard a heavy vessel operating at relatively high speeds in the Mississippi River. Further, "increased emphasis" on having the anchors at the ready may even provide a false sense of security without effectively addressing the dangers inherent in operating heavy vessels at high speed in proximity to shoreside businesses and other marine traffic.

As a result of its investigation of the *Bright Field* accident, the National Transportation Safety Board makes the following safety recommendations to the Associated Federal Pilots and Docking Masters of Louisiana, Inc.:

> Participate with the U.S. Coast Guard and other stakeholders in a comprehensive risk assessment that considers all activities, marine and shoreside, within the Port of New Orleans. (M-98-29)
>
> In cooperation with the U.S. Coast Guard and other stakeholders, including Federal, State, and local agencies; private commercial entities; shipowners; and pilot associations, implement risk-management and risk-mitigation initiatives that will ensure the safety of people and property within the Port of New Orleans. (M-98-30)

Also, the Safety Board issued Safety Recommendations M-98-1 through -4 to the U.S. Coast Guard; M-98-5 and -6 to the U.S. Army Corps of Engineers; M-98-7 and -8 to the State of Louisiana; M-98-9 through -12 to the Board of Commissioners of the Port of New Orleans; M-98-13 through -15 to International RiverCenter; M-98-16 through -18 to Clearsky Shipping Company; M-98-19 through -23 to New Orleans Paddlewheels, Inc.; M-98-24 through -26 to the New Orleans Baton Rouge Steamship Pilots Association; and M-98-27 and -28 to the Crescent River Port Pilots Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations M-98-29 and -30 in your reply. If you need additional information, you may call (202) 314-6450.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 25, 1998

In reply refer to: R-98-1 through -7

Honorable Jolene M. Molitoris
Administrator
Federal Railroad Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

On January 12, 1997, about 11:52 a.m. Pacific standard time, the Union Pacific Railroad (UP) unit freight train 6205 west derailed 68 cars on the UP Los Angeles Subdivision, milepost (MP) 238.7, near Kelso, California. The train consisted of 3 locomotive units and 75 loaded covered hopper cars. While descending Cima Hill, the engineer inadvertently activated the multiple-unit (MU) engine shutdown switch, which shut down all the locomotive unit diesel engines and eliminated the train's dynamic braking capability. The train rapidly accelerated beyond the 20-mph authorized speed limit despite the engineer's efforts to increase the train's air braking, which the engineer placed in emergency 1 minute and 2 seconds after dynamic braking loss. The train's consist weight was listed at an average of 13 tons per car less than the train actually weighed. The train eventually reached a speed of 72 mph and derailed 68 of its 75 cars while exiting a siding near Kelso, California.[1] No fatalities, injuries, fires, or hazardous materials releases resulted from the accident. The total damage cost was $4,376,400.

Placement of safety-critical controls was one of the major safety issues raised by this accident. Early in the National Transportation Safety Board investigation, it became apparent that the locomotive engineer had inadvertently activated the MU engine stop switch inside the lead locomotive unit. The red Stop button of the MU engine stop switch was found still depressed after the accident. Also, the suddenness with which the engine shutdown occurred indicated that the switch had been struck immediately before the accident. No other reason for the engine shutdown was discovered.

The activation of the MU engine stop switch precipitated the accident. The stop switch activation shut down the diesel engines, resulting in dynamic braking loss. The dynamic brake loss initiated the runaway. Because neither the engineer nor the conductor was aware of what had

[1]For additional information, read Railroad Accident Report — *Derailment of Union Pacific Railroad Freight Train 6205 West Near Kelso, California, January 12, 1997* (NTSB/RAR-98/01).

caused the locomotive units to shut down, they did not take action to reactivate the units or immediately place the train in emergency. By the time the crewmembers put the train in emergency, it was already in runaway status.

The placement of the MU engine stop switch on the lower left panel of the engineer's control console made it subject to inadvertent activation. Investigators' informal postaccident discussions with locomotive engineers revealed that such activations had been common on locomotives equipped with switches in the same location. Sometime after 1989, General Motors Electro-Motive Division (EMD), the builder of the SD60M locomotive, became aware that inadvertent activation of the MU engine stop switch was a problem. EMD attempted to work with the purchasers of the affected locomotives to correct the poor placement of the switch.

While EMD's attempts to address the problem evidenced some concern over the safety implications of the switch location, the UP management did not consider changing the location a priority modification. Instead, the UP categorized it as a "comfort or convenience" modification. Consequently, the UP did not expedite protection or relocation of the switches. Although EMD had communicated with the UP about this issue as early as January 1990, the UP had taken steps to modify the MU engine stop switches on only 8 of its 184 affected SD60M locomotives by 1996. None of the affected UP locomotives had had their switches relocated.

Correspondence between UP representatives and EMD revealed that some UP representatives and EMD understood that the location of the MU engine shutdown switch had safety implications because crewmembers could, by inadvertently activating the switch, simultaneously shut down all locomotive units. The correspondence indicated concern regarding this possibility. Safety-conscious railroad managers should have foreseen that an unintentional shutdown of all motive power on an operating train could jeopardize train control. This danger should have been particularly conspicuous with respect to trains that traveled on steep grades such as Cima Hill, where dynamic braking has become critical. The Safety Board concluded that the failure of UP management to recognize the MU engine shutdown switch location as a safety hazard and to expedite effective switch protection or relocation created the conditions that led to the accident.

The Kelso accident also raised the issues of train speed and braking safety margins. The rapidity with which the Kelso train engineer was overtaken by events underscores the need for railroads to maintain realistic operating safety margins in case an unexpected failure occurs. Safety margins that were adequate for rail operations 20 years ago are not necessarily adequate today. As time has passed, railroad equipment technology has progressed, and so have the size and weight of freight cars and the weight and speed of trains. These changes have altered the ways trains operate, particularly in steep-grade areas, and have eroded the efficacy of braking safety margins.

Engineers' determinations of safe maximum train speeds and train-handling methods are made based on the weight of the train (trailing tonnage). The train's tonnage dictates to the engineer the maximum speeds and the braking methods that may be used and indicates whether air brake retainer valves must be set. The accuracy of the engineer's determinations regarding these train-handling limits depends on the accuracy of the figures used to report the weight of each freight car.

Unless the engineer is provided with the correct weight or appropriate maximum weight for the train on which to base his determinations, he may be placed in a potentially dangerous situation.

According to the UP, train 6205's cars were initially assigned by computer the default maximum car weight of 143 tons each, which was then mistakenly changed by a clerk to approximately 130 tons each. The engineer used the inaccurate weights in making his train-handling decisions. Postaccident car weights were found to be around 143 tons. The additional train weight of 975 tons was unknown to the engineer.

Regardless of whether the engineer knew the actual weight of the train, the maximum authorized train speed down Cima Hill for train 6205 west would have been 20 mph. But beyond the fixed limit of authorized speed, engineers control trains by making experience-based judgments as dictated by conditions. As such, the accident engineer would probably not have significantly altered his braking procedure down the grade had he known the actual train weight, beyond increasing dynamic and pneumatic braking as he felt necessary to control the train. The unknown additional weight, however, eroded any safety margin that had been built into the UP's speed requirements for bringing a train down Cima Hill. Further, the greater weight would have caused the train to speed down the grade faster than it would have at a lower weight and impelled it more quickly beyond the point of no return. Therefore, the Safety Board concluded that, although the unknown additional train weight of 975 tons was not causal to the accident, it contributed to the severity and magnitude of the derailment.

Of additional concern regarding train speed and braking margins, research has shown that train wheels and brake shoes cannot withstand infinite levels of friction-generated heat. Too much heat generated during braking causes brake shoes to wear and deteriorate rapidly, metal to flow on the wheel tread, and trains to lose their stopping ability. In the past, the use of air brake retainer valves (retainers) allowed engineers to control trains down long grades without exceeding the limits of the brake equipment. Then, air brake system air capacity was the limiting factor. Retainers help preserve compressed air capacity and the potential capability to brake a train. Retainers, however, still depend on the same tread-braked system that is subject to heat limitations. With or without retainers, excessive heat at the tread brake can cause the air braking system to become ineffective.

Evidence from the Kelso accident suggests that train weights and speed levels may have reached the physical limitations of the tread-braked freight car. The engineer was attempting to keep the train within the 20-mph speed limit established by the UP for a train of that weight at that location. Retainers had been set. The train's air brakes were functioning properly and the engineer used the brakes correctly. But even after he had placed the train's tread-braked cars in emergency at 30 mph, the engineer of the accident train could not stop it from running away. The air brakes alone were insufficient to keep the train from experiencing significant acceleration in these circumstances. Postaccident UP brake tests conducted on Cima Hill showed that the air brakes alone could stop a train similar to the accident train at speeds up to 25 mph but not much beyond that speed. The accident train accelerated to 25 mph within 30 seconds of MU stop switch activation.

The accident train, therefore, while it was performing as required by the UP, could not be sufficiently slowed with air brakes alone on the Cima Hill downgrade to ensure safe operation

much beyond the maximum authorized speed. The data indicate that the air brakes could not function successfully in this situation because frictional tread-brake heat generation had reached performance-damaging levels. The Safety Board concluded that, due to increases in train weights and speeds, frictional tread-brake heat generation has become a limiting factor for safe train operation, particularly in steep-grade territories.

The Kelso accident also illustrated that dynamic braking use has affected safe train speeds and braking margins. While the UP in theory considers dynamic braking a nonessential mechanism, it has in practice relied on the safeguard that, as long as the dynamic braking system works, total dependence on the air brakes (with their heat-fade weaknesses) can be avoided. As the Kelso accident demonstrated, once dynamic braking is lost, a train operating on a steep downgrade can become uncontrollable within seconds, even though the air brake system is fully functional. The Safety Board therefore concluded that the UP's operational reliance on dynamic braking for controlling heavy and fast-moving trains on steep grades, without acknowledging and protecting dynamic braking as a safety-critical system, is imprudent. The fact that the accident occurred because dynamic braking was lost indicates that some railroads may have allowed their margins of safety to erode by maintaining train-handling practices rendered obsolete by the heavier weights and faster speeds of today's trains.

Operational speeds and train-stopping capability have traditionally been associated with the amount of air pressure that has been reduced from the brake pipe (the level of air braking required). The UP required that a train be stopped after an 18-psi brake pipe pressure reduction failed to control train speed. Other railroads had similar requirements. The Safety Board does not consider that such brake pipe reduction requirements provide timely operational guidance or a sufficient safety margin to traincrews. By the time a dangerous situation is recognized, it may already be too late for crewmembers to take effective corrective action. In the Kelso accident, although he was attempting to abide by the UP's maximum train speed requirement for the area, by the time the engineer realized that a problem existed and initiated a 12- to 17-psi reduction, the train still became a runaway within 62 seconds. The Safety Board therefore concluded that the UP has authorized maximum train speeds that provide insufficient safety margins in the event of dynamic braking failure.

According to the UP rules in effect for the accident train, 20 mph was the maximum safe speed for a train descending from Cima to Kelso with retainers set. After the accident, the UP issued orders that required trains on which retainers had been set to keep speeds at 15 mph or lower. The UP also required its crews operating in specified steep-grade locations, including the descent from Cima to Kelso, to stop trains immediately if speeds rose 5 mph above the authorized speed. While the exact speed at which the engineer might have effectively braked train 6205, given all the variables in this instance, has not been determined by investigators, the Safety Board concluded that some speed-based safeguard might have enabled the engineer to exercise greater control over the Kelso accident train.

The Safety Board considers that the UP's decision to implement the "plus 5 mph and stop" rule specified above is a step in the right direction. Nevertheless, the Safety Board

considers that this narrowly defined order may not be sufficient to address the broad range of safety margin issues raised by this accident.

The Kelso accident also highlighted how important dynamic braking has become to railroad safety. The railroad industry maintains that dynamic braking is a noncritical feature. Railroads have claimed that dynamic brakes are not required for safety or train control and that the main purposes of dynamic brake use are fuel economy and maintenance reduction. Because regulations require that trains be safely handled with the air brake system alone, railroads do not acknowledge that dynamic brakes have become an important safety and train-handling feature. Actual railroad rules and train-handling routines, however, indicate that, in practice, dynamic brakes have become essential to train handling. During the Kelso accident, the train accelerated beyond the stopping speed of the train very rapidly (within 30 seconds) after dynamic brake loss. Therefore, the Safety Board concluded that railroads are operating trains in situations in which loss of dynamic braking will result in loss of train control.

The Safety Board has a history of recommendations regarding dynamic brakes. As a result of the investigation of an accident that took place at San Bernardino, California, in May 1989,[2] the Safety Board recommended that the FRA:

> Revise regulations to require that if a locomotive unit is equipped with dynamic brakes, the dynamic brakes function. (R-90-024)

On November 30, 1990, the FRA responded that it was reviewing the issue of regulations pertaining to dynamic brakes on locomotives and specified a range of responses available to the agency. The FRA, however, chose not to make a "definitive response" to the recommendation. On February 21, 1991, the Safety Board responded that the recommendation would remain classified "Open—Await Response" because of the FRA's lack of commitment to a specific action. Since then, the FRA has taken two actions in response to Safety Recommendation R-90-024, both of which were unsuccessful. First, the FRA issued a proposed rulemaking under the amendment of the Power Brake Law. The rulemaking was ultimately withdrawn. The FRA then placed the recommended action with its Railroad Safety Advisory Committee (RSAC) for handling. The RSAC was also unable to develop a satisfactory solution to the problem of providing for functioning dynamic brakes.

Separating high-priority components of needed rulemaking from the routine process and proposing them independently has been a successful strategy in the past, most recently with respect to the two-way end-of-train device recommendations resulting from the 1996 Cajon, California, derailment.[3] Because no progress on Safety Recommendation R-90-024 has been achieved in approximately 7 years, the Safety Board classifies Safety Recommendation R-90-024

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[2]Railroad Accident Report — *Derailment of Southern Pacific Transportation Company Freight Train on May 12, 1989, and Subsequent Rupture of Calnev Pipeline on May 25, 1989, at San Bernardino, California* (NTSB/RAR-90/02).

[3]Railroad Accident Report — *Derailment of Freight Train H-BALTI-31 Atchison, Topeka, and Santa Fe Railway Company near Cajon Junction, California, February 1, 1996* (NTSB/RAR-96/05).

"Closed—Unacceptable Action/Superseded." The Safety Board concluded that the FRA should separate the dynamic brake requirements from the Power Brake Law rulemaking and immediately conclude rulemaking to require that railroads verify that the dynamic braking systems on all locomotives equipped with dynamic brakes are functioning properly before trains are dispatched.

In addition, as a result of the San Bernardino accident, the Safety Board made a recommendation to the FRA to:

> Study in conjunction with the Association of American Railroads the feasibility of developing a positive method to indicate to the operating engineer in the cab of the controlling locomotive unit the condition of the dynamic brakes on all units in the train. (R-90-023)

The FRA also considered this issue part of the proposed revisions of the Power Brake Law, which, as noted above, have not been successfully advanced. Consequently, the Safety Board classified Safety Recommendation R-90-023 "Open—Unacceptable Action."

Despite these recommendations, reliable information on the status of a train's dynamic braking is still not available to the engineer. The engineer of the Kelso accident train had reason to question whether the dynamic braking system was operative on his train. Although he apparently did not consider this issue, a bad order tag indicating malfunctioning dynamic brakes had been left on one of the train's locomotives. This bad order tag could have caused the engineer to doubt the reliability of the train's dynamic braking system. He had performed a running dynamic brake test from MP 309.3 to MP 292, and the brakes had responded as expected, although the engineer still could not know whether they functioned as designed. Cima is located approximately 37 miles past this checkpoint, at MP 254.6. The engineer made no further dynamic braking tests before reaching Cima and so had no verified information on whether or how the dynamic brakes were functioning as the train neared this significant downgrade.

Although the engineer assumed (in accordance with UP policy) that the brakes were operational, he had no means of checking whether they were, aside from conducting additional tests. No equipment in the lead locomotive provided information on the train's dynamic braking status. The Safety Board therefore concluded that the engineer in the Kelso accident had no practical means of knowing if or how many of his locomotive units were properly working in dynamic braking immediately before the accident or when used.

In recent years, the railroad industry has developed an effective and reliable device to display the real-time dynamic braking performance of trailing locomotive units. Such a display would permit an engineer to modify his train-handling strategy based on the information it provided, before being surprised by the failure of a dynamic braking system that he had depended upon using. The Safety Board concluded that installing a device in the cab of each controlling locomotive to indicate the real-time condition of the dynamic brakes on each locomotive unit in the consist would give valuable information to the engineer on train dynamic braking capability at any given moment. Therefore, since no progress has been made by the FRA

on Safety Recommendation R-90-023, which addresses developing a positive method to indicate to the engineer the condition of the locomotives' dynamic brakes, the Safety Board classifies R-90-023 "Closed—Unacceptable Action/Superseded."

Finally, during the Kelso accident investigation, the Safety Board learned that UP personnel had not been formally trained on the appropriate way to set or use air brake pressure-retaining valves. Neither the conductor nor the engineer on the Kelso accident train had had any formal training on when or how to set the retainers, even though the practice was required by the UP and important to braking safety in steep areas. Both crewmembers said they had gained all the knowledge they had about retainers through on-the-job training and experience.

In this instance, the conductor precharged the brake cylinders by setting most of the retainers while the train brakes were still applied. Investigators were unable to determine with certainty whether this action had any effect upon the unfolding of events in the Kelso accident. Such a precharge may or may not be significant, depending on conditions and future braking actions, since any additional braking will be added to that pressure already in the precharged cylinders.

The crucial point is that neither the conductor nor the engineer had a well-defined plan about when the retainers should be set or how they should be charged. Neither had a true appreciation of the significance of uncharged or precharged brake cylinders. Further, neither understood the proper use of retainers in controlling train speed through cycle braking. Because the engineer did not release the air brakes on the accident train's descent down Cima Hill, the retainers could not function as designed and were rendered effectively useless.

It seems self-evident that any procedure that is important enough to be required by a railroad should be well understood by railroad personnel and included in the railroad's formal training program. The Safety Board concluded that the significance of retainer-setting procedures, proper retainer use, and the various choices involved should be understood by train crewmembers and included in railroad training programs.

Based on the foregoing information, the National Transportation Safety Board issues the following recommendations to the Federal Railroad Administration:

Alert locomotive manufacturers and railroad operators about the dangers posed by improperly located safety-significant controls and switches in locomotives. (R-98-1)

Require railroads to ensure that the actual loaded weights of cars in a train are provided to the traincrew or, if the loaded weights are unknown, to implement a method to ensure that the maximum loaded weight is assigned. (R-98-2)

Require railroads to review steep-grade train-handling practices and, if necessary, make changes that will preserve a margin of stopping ability should a dynamic braking system fail. (R-98-3)

Carry out research, investigation, and analysis to determine maximum authorized train speeds for safe operation of trains of all weights, using speed-based margins of safety that can be easily measured by traincrews. (R-98-4)

Separate the dynamic brake requirements from the Power Brake Law rulemaking and immediately conclude rulemaking to require that railroads verify that the dynamic braking systems on all locomotives equipped with dynamic brakes are functioning properly before trains are dispatched. (R-98-5)

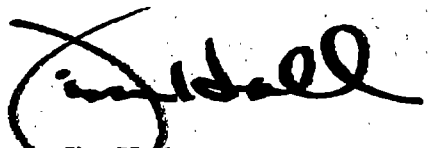
Require railroads to ensure that all locomotives with dynamic braking be equipped with a device in the cab of the controlling locomotive unit to indicate to the operating engineer the real-time condition of the dynamic brakes on each trailing unit. (R-98-6)

Require railroads to implement formal training on correct retainer setting and using procedures for traincrew members who may set or use air brake retainer valves. (R-98-7)

Also, the Safety Board issued Safety Recommendations R-98-8 and -9 to the Association of American Railroads, and R-98-10 through -16 to the Union Pacific Railroad.

Please refer to Safety Recommendations R-98-1 through -7 in your reply. If you need additional information, you may call (202) 314-6438.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.



By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 25, 1998

In reply refer to: R-98-8 and -9

Mr. M. B. Oglesby, Jr.
President
Association of American Railroads
American Railroads Building
50 F Street, N.W.
Washington, D.C. 20001

On January 12, 1997, about 11:52 a.m. Pacific standard time, the Union Pacific Railroad (UP) unit freight train 6205 west derailed 68 cars on the UP Los Angeles Subdivision, milepost 238.7, near Kelso, California. The train consisted of 3 locomotive units and 75 loaded covered hopper cars. While descending Cima Hill, the engineer inadvertently activated the multiple-unit (MU) engine shutdown switch, which shut down all the locomotive unit diesel engines and eliminated the train's dynamic braking capability. The train rapidly accelerated beyond the 20-mph authorized speed limit despite the engineer's efforts to increase the train's air braking, which the engineer placed in emergency 1 minute and 2 seconds after dynamic braking loss. The train's consist weight was listed at an average of 13 tons per car less than the train actually weighed. The train eventually reached a speed of 72 mph and derailed 68 of its 75 cars while exiting a siding near Kelso, California.[1] No fatalities, injuries, fires, or hazardous materials releases resulted from the accident. The total damage cost was $4,376,400.

Placement of safety-critical controls was one of the major safety issues raised by this accident. Early in the National Transportation Safety Board investigation, it became apparent that the locomotive engineer had inadvertently activated the MU engine stop switch inside the lead locomotive unit. The red Stop button of the MU engine stop switch was found still depressed after the accident. Also, the suddenness with which the engine shutdown occurred indicated that the switch had been struck immediately before the accident. No other reason for the engine shutdown was discovered.

The activation of the MU engine stop switch precipitated the accident. The stop switch activation shut down the diesel engines, resulting in dynamic braking loss. The dynamic brake loss

[1]For additional information, read Railroad Accident Report — *Derailment of Union Pacific Railroad Freight Train 6205 West Near Kelso, California, January 12, 1997* (NTSB/RAR-98/01).

initiated the runaway. Because neither the engineer nor the conductor was aware of what had caused the locomotive units to shut down, they did not take action to reactivate the units or immediately place the train in emergency. By the time the crewmembers put the train in emergency, it was already in runaway status.

The placement of the MU engine stop switch on the lower left panel of the engineer's control console made it subject to inadvertent activation. Investigators' informal postaccident discussions with locomotive engineers revealed that such activations had been common on locomotives equipped with switches in the same location. Sometime after 1989, General Motors Electro-Motive Division (EMD), the builder of the SD60M locomotive, became aware that inadvertent activation of the MU engine stop switch was a problem. EMD attempted to work with the purchasers of the affected locomotives to correct the poor placement of the switch.

While EMD's attempts to address the problem evidenced some concern over the safety implications of the switch location, the UP management did not consider changing the location a priority modification. Instead, the UP categorized it as a "comfort or convenience" modification. Consequently, the UP did not expedite protection or relocation of the switches. Although EMD had communicated with the UP about this issue as early as January 1990, the UP had taken steps to modify the MU engine stop switches on only 8 of its 184 affected SD60M locomotives by 1996. None of the affected UP locomotives had had their switches relocated.

Correspondence between UP representatives and EMD revealed that some UP representatives and EMD understood that the location of the MU engine shutdown switch had safety implications because crewmembers could, by inadvertently activating the switch, simultaneously shut down all locomotive units. The correspondence indicated concern regarding this possibility. Safety-conscious railroad managers should have foreseen that an unintentional shutdown of all motive power on an operating train could jeopardize train control. This danger should have been particularly conspicuous with respect to trains that traveled on steep grades such as Cima Hill, where dynamic braking has become critical. The Safety Board concluded that the failure of UP management to recognize the MU engine shutdown switch location as a safety hazard and to expedite effective switch protection or relocation created the conditions that led to the accident.

The Kelso accident also raised the issues of train speed and braking safety margins. The rapidity with which the Kelso train engineer was overtaken by events underscores the need for railroads to maintain realistic operating safety margins in case an unexpected failure occurs. Safety margins that were adequate for rail operations 20 years ago are not necessarily adequate today. As time has passed, railroad equipment technology has progressed, and so have the size and weight of freight cars and the weight and speed of trains. These changes have altered the ways trains operate, particularly in steep-grade areas, and have eroded the efficacy of braking safety margins.

Engineers' determinations of safe maximum train speeds and train-handling methods are made based on the weight of the train (trailing tonnage). The train's tonnage dictates to the engineer the maximum speeds and the braking methods that may be used and indicates whether air brake retainer valves must be set. The accuracy of the engineer's determinations regarding these train-handling limits depends on the accuracy of the figures used to report the weight of each freight car.

Unless the engineer is provided with the correct weight or appropriate maximum weight for the train on which to base his determinations, he may be placed in a potentially dangerous situation.

Of additional concern regarding train speed and braking margins, research has shown that train wheels and brake shoes cannot withstand infinite levels of friction-generated heat. Too much heat generated during braking causes brake shoes to wear and deteriorate rapidly, metal to flow on the wheel tread, and trains to lose their stopping ability. In the past, the use of air brake retainer valves (retainers) allowed engineers to control trains down long grades without exceeding the limits of the brake equipment. Then, air brake system air capacity was the limiting factor. Retainers help preserve compressed air capacity and the potential capability to brake a train. Retainers, however, still depend on the same tread-braked system that is subject to heat limitations. With or without retainers, excessive heat at the tread brake can cause the air braking system to become ineffective.

Evidence from the Kelso accident suggests that train weights and speed levels may have reached the physical limitations of the tread-braked freight car. The engineer was attempting to keep the train within the 20-mph speed limit established by the UP for a train of that weight at that location. Retainers had been set. The train's air brakes were functioning properly and the engineer used the brakes correctly. But even after he had placed the train's tread-braked cars in emergency at 30 mph, the engineer of the accident train could not stop it from running away. The air brakes alone were insufficient to keep the train from experiencing significant acceleration in these circumstances. Postaccident UP brake tests conducted on Cima Hill showed that the air brakes alone could stop a train similar to the accident train at speeds up to 25 mph but not much beyond that speed. The accident train accelerated to 25 mph within 30 seconds of MU stop switch activation.

The accident train, therefore, while it was performing as required by the UP, could not be sufficiently slowed with air brakes alone on the Cima Hill downgrade to ensure safe operation much beyond the maximum authorized speed. The data indicate that the air brakes could not function successfully in this situation because frictional tread-brake heat generation had reached performance-damaging levels. The Safety Board concluded that, due to increases in train weights and speeds, frictional tread-brake heat generation has become a limiting factor for safe train operation, particularly in steep-grade territories.

The Kelso accident also illustrated that dynamic braking use has affected safe train speeds and braking margins. While the UP in theory considers dynamic braking a nonessential mechanism, it has in practice relied on the safeguard that, as long as the dynamic braking system works, total dependence on the air brakes (with their heat-fade weaknesses) can be avoided. As the Kelso accident demonstrated, once dynamic braking is lost, a train operating on a steep downgrade can become uncontrollable within seconds, even though the air brake system is fully functional. The Safety Board therefore concluded that the UP's operational reliance on dynamic braking for controlling heavy and fast-moving trains on steep grades, without acknowledging and protecting dynamic braking as a safety-critical system, is imprudent. The fact that the accident occurred because dynamic braking was lost indicates that some railroads may have allowed their margins of safety to erode by maintaining train-handling practices rendered obsolete by the heavier weights and faster speeds of today's trains.

Operational speeds and train-stopping capability have traditionally been associated with the amount of air pressure that has been reduced from the brake pipe (the level of air braking required). The UP required that a train be stopped after an 18-psi brake pipe pressure reduction failed to control train speed. Other railroads had similar requirements. The Safety Board does not consider that such brake pipe reduction requirements provide timely operational guidance or a sufficient safety margin to traincrews. By the time a dangerous situation is recognized, it may already be too late for crewmembers to take effective corrective action. In the Kelso accident, although he was attempting to abide by the UP's maximum train speed requirement for the area, by the time the engineer realized that a problem existed and initiated a 12- to 17-psi reduction, the train still became a runaway within 62 seconds. The Safety Board therefore concluded that the UP has authorized maximum train speeds that provide insufficient safety margins in the event of dynamic braking failure.

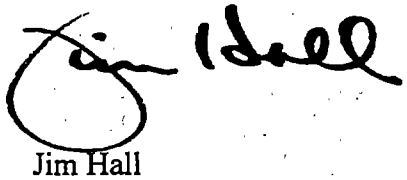
Based on the foregoing information, the National Transportation Safety Board issues the following recommendations to the Association of American Railroads:

> Alert locomotive manufacturers and railroad operators about the dangers posed by improperly located safety-significant controls and switches in locomotives. (R-98-8)
>
> Carry out research, investigation, and analysis to determine maximum authorized train speeds for safe operation of trains of all weights, using speed-based margins of safety that can be easily measured by traincrews. (R-98-9)

Also, the Safety Board issued Safety Recommendations R-98-1 through -7 to the Federal Railroad Administration and R-98-10 through -16 to the Union Pacific Railroad.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations R-98-8 and-9 in your reply. If you need additional information, you may call (202) 314-6438.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.



By: Jim Hall
Chairman

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 25, 1998

In reply refer to: R-98-10 through -16

Mr. Jerry R. Davis
President and Chief Operating Officer
Union Pacific Railroad
1416 Dodge Street, Room 1230
Omaha, Nebraska 68179

On January 12, 1997, about 11:52 a.m. Pacific standard time, the UP unit freight train 6205 west derailed 68 cars on the UP Los Angeles Subdivision, milepost (MP) 238.7, near Kelso, California. The train consisted of 3 locomotive units and 75 loaded covered hopper cars. While descending Cima Hill, the engineer inadvertently activated the multiple-unit (MU) engine shutdown switch, which shut down all the locomotive unit diesel engines and eliminated the train's dynamic braking capability. The train rapidly accelerated beyond the 20-mph authorized speed limit despite the engineer's efforts to increase the train's air braking, which the engineer placed in emergency 1 minute and 2 seconds after dynamic braking loss. The train's consist weight was listed at an average of 13 tons per car less than the train actually weighed. The train eventually reached a speed of 72 mph and derailed 68 of its 75 cars while exiting a siding near Kelso, California.[1] No fatalities, injuries, fires, or hazardous materials releases resulted from the accident. The total damage cost was $4,376,400.

The National Transportation Safety Board determined that the probable cause of the derailment was (1) a prolonged pattern of inattention and lack of action by Union Pacific Railroad management to protect effectively or relocate the multiple-unit engine shutdown switch in SD60M locomotives after the switch had repeatedly been recognized as subject to inadvertent activation; and (2) failure of Union Pacific Railroad management to adequately address critical safety issues such as dynamic braking system operational reliance and protection, and authorized maximum train speeds in the event of dynamic braking failure. Contributing to the severity of the accident was the failure of Union Pacific Railroad management to ensure accurate car weight assessment and training for operating personnel on retainer-setting procedures and effects.

[1]For additional information, read Railroad Accident Report — *Derailment of Union Pacific Railroad Freight Train 6205 West Near Kelso, California, January 12, 1997* (NTSB/RAR-98/01).

Placement of safety-critical controls was one of the major safety issues raised by this accident. Early in the investigation, it became apparent that the locomotive engineer had inadvertently activated the MU engine stop switch inside the lead locomotive unit. The red Stop button of the MU engine stop switch was found still depressed after the accident. Also, the suddenness with which the engine shutdown occurred indicated that the switch had been struck immediately before the accident. No other reason for the engine shutdown was discovered.

The activation of the MU engine stop switch precipitated the accident. The stop switch activation shut down the diesel engines, resulting in dynamic braking loss. The dynamic brake loss initiated the runaway. Because neither the engineer nor the conductor was aware of what had caused the locomotive units to shut down, they did not take action to reactivate the units or immediately place the train in emergency. By the time the crewmembers put the train in emergency, it was already in runaway status.

The placement of the MU engine stop switch on the lower left panel of the engineer's control console made it subject to inadvertent activation. Investigators' informal postaccident discussions with locomotive engineers revealed that such activations had been common on locomotives equipped with switches in the same location. Sometime after 1989, General Motors Electro-Motive Division (EMD), the builder of the SD60M locomotive, became aware that inadvertent activation of the MU engine stop switch was a problem. EMD attempted to work with the purchasers of the affected locomotives to correct the poor placement of the switch.

While EMD's attempts to address the problem evidenced some concern over the safety implications of the switch location, the UP management did not consider changing the location a priority modification. Instead, the UP categorized it as a "comfort or convenience" modification. Consequently, the UP did not expedite protection or relocation of the switches. Although EMD had communicated with the UP about this issue as early as January 1990, the UP had taken steps to modify the MU engine stop switches on only 8 of its 184 affected SD60M locomotives by 1996. None of the affected UP locomotives had had their switches relocated.

Correspondence between UP representatives and EMD revealed that some UP representatives and EMD understood that the location of the MU engine shutdown switch had safety implications because crewmembers could, by inadvertently activating the switch, simultaneously shut down all locomotive units. The correspondence indicated concern regarding this possibility. Safety-conscious railroad managers should have foreseen that an unintentional shutdown of all motive power on an operating train could jeopardize train control. This danger should have been particularly conspicuous with respect to trains that traveled on steep grades such as Cima Hill, where dynamic braking has become critical. The Safety Board concluded that the failure of UP management to recognize the MU engine shutdown switch location as a safety hazard and to expedite effective switch protection or relocation created the conditions that led to the accident.

The Kelso accident also indicated that braking safety margins for trains operating in steep-grade areas may not be sufficient. The rapidity with which the Kelso train engineer was overtaken by events underscores the need for railroads to maintain realistic operating safety margins in case an unexpected failure occurs. Safety margins that were adequate for rail operations 20 years ago are

not necessarily adequate today. As time has passed, railroad equipment technology has progressed, and so have the size and weight of freight cars and the weight and speed of trains. These changes have altered the ways trains operate, particularly in steep-grade areas, and have eroded the efficacy of braking safety margins.

Engineers' determinations of safe maximum train speeds and train-handling methods are made based on the weight of the train (trailing tonnage). The train's tonnage dictates to the engineer the maximum speeds and the braking methods that may be used and indicates whether air brake retainer valves must be set. The accuracy of the engineer's determinations regarding these train-handling limits depends on the accuracy of the figures used to report the weight of each freight car. Unless the engineer is provided with the correct weight or appropriate maximum weight for the train on which to base his determinations, he may be placed in a potentially dangerous situation.

Train 6205's cars were initially assigned by computer the default maximum car weight of 143 tons each, which was then mistakenly changed by a clerk to approximately 130 tons each. The engineer used the inaccurate weights in making his train-handling decisions. Postaccident car weights were found to be around 143 tons. The additional train weight of 975 tons was unknown to the engineer.

Regardless of whether the engineer knew the actual weight of the train, the maximum authorized train speed down Cima Hill for train 6205 west would have been 20 mph. But beyond the fixed limit of authorized speed, engineers control trains by making experience-based judgments as dictated by conditions. As such, the accident engineer would probably not have significantly altered his braking procedure down the grade had he known the actual train weight, beyond increasing dynamic and pneumatic braking as he felt necessary to control the train. The unknown additional weight, however, eroded any safety margin that had been built into the UP's speed requirements for bringing a train down Cima Hill. Further, the greater weight would have caused the train to speed down the grade faster than it would have at a lower weight and impelled it more quickly beyond the point of no return. Therefore, the Safety Board concluded that, although the unknown additional train weight of 975 tons was not causal to the accident, it contributed to the severity and magnitude of the derailment.

Kelso accident investigators found that, following the Kelso derailment, the UP established a procedure to prevent billing clerks from altering the consist weights of cars and trains, thereby intending to prevent inaccurate train weights from being transmitted to engineers. Such a procedure, however, does not prevent cars from being overloaded beyond their design limits. Since the Kelso accident, the UP experienced another incident that indicated that inaccurate car weight reporting continues to affect the railroad. About 4 p.m. Pacific daylight time, on August 31, 1997, the eastbound UP train CSULA-30 collided with a Burlington Northern Santa Fe train at Barstow, California. The UP train was a unit train of 72 cars, carrying contaminated soil bound for Utah. The UP cars were weighed during the postaccident investigation and found to weigh, on average, 5 tons more than the train consist weight of 121 tons per car, which caused the train to be 360 tons heavier than its listed consist weight. Based on these findings, the Safety Board concluded that the issue of accurate car weight assignment has not been adequately addressed by the UP.

Research has shown that train wheels and brake shoes cannot withstand infinite levels of friction-generated heat. Too much heat generated during braking causes brake shoes to wear and deteriorate rapidly, metal to flow on the wheel tread, and trains to lose their stopping ability. In the past, the use of air brake retainer valves (retainers) allowed engineers to control trains down long grades without exceeding the limits of the brake equipment. Then, air brake system air capacity was the limiting factor. Retainers help preserve compressed air capacity and the potential capability to brake a train. Retainers, however, still depend on the same tread-braked system that is subject to heat limitations. With or without retainers, excessive heat at the tread brake can cause the air braking system to become ineffective.

Evidence from the Kelso accident suggests that train weights and speed levels may have reached the physical limitations of the tread-braked freight car. The engineer was attempting to keep the train within the 20-mph speed limit established by the UP for a train of that weight at that location. Retainers had been set. The train's air brakes were functioning properly and the engineer used the brakes correctly. But even after he had placed the train's tread-braked cars in emergency at 30 mph, the engineer of the accident train could not stop it from running away. The air brakes alone were insufficient to keep the train from experiencing significant acceleration in these circumstances.

Postaccident UP brake tests conducted on Cima Hill showed that the air brakes alone could stop a train similar to the accident train at speeds up to 25 mph but not much beyond that speed. The accident train accelerated to 25 mph within 30 seconds of MU stop switch activation. The accident train, therefore, while it was performing as required by the UP, could not be sufficiently slowed with air brakes alone on the Cima Hill downgrade to ensure safe operation much beyond the maximum authorized speed. The data indicate that the air brakes could not function successfully in this situation because frictional tread-brake heat generation had reached performance-damaging levels. The Safety Board concluded that, due to increases in train weights and speeds, frictional tread-brake heat generation has become a limiting factor for safe train operation, particularly in steep-grade territories.

While the UP in theory considers dynamic braking a nonessential mechanism, it has in practice relied on the safeguard that, as long as the dynamic braking system works, total dependence on the air brakes (with their heat-fade weaknesses) can be avoided. As the Kelso accident demonstrated, once dynamic braking is lost, a train operating on a steep downgrade can become uncontrollable within seconds, even though the air brake system is fully functional. The Safety Board therefore concluded that the UP's operational reliance on dynamic braking for controlling heavy and fast-moving trains on steep grades, without acknowledging and protecting dynamic braking as a safety-critical system, is imprudent. The fact that the accident occurred because dynamic braking was lost indicates that some railroads may have allowed their margins of safety to erode by maintaining train-handling practices rendered obsolete by the heavier weights and faster speeds of today's trains.

Operational speeds and train-stopping capability have traditionally been associated with the amount of air pressure that has been reduced from the brake pipe (the level of air braking required). The UP required that a train be stopped after an 18-psi brake pipe pressure reduction failed to

control train speed. The Safety Board does not consider that such brake pipe reduction requirements provide timely operational guidance or a sufficient safety margin to traincrews. By the time a dangerous situation is recognized, it may already be too late for crewmembers to take effective corrective action. In the Kelso accident, although he was attempting to abide by the UP's maximum train speed requirement for the area, by the time the engineer realized that a problem existed and initiated a 12- to 17-psi reduction, the train still became a runaway within 62 seconds. The Safety Board therefore concluded that the UP has authorized maximum train speeds that provide insufficient safety margins in the event of dynamic braking failure.

According to the UP rules in effect for the accident train, 20 mph was the maximum safe speed for a train descending from Cima to Kelso with retainers set. After the accident, the UP issued orders that required trains on which retainers had been set to keep speeds at 15 mph or lower. The UP also required its crews operating in specified steep-grade locations, including the descent from Cima to Kelso, to stop trains immediately if speeds rose 5 mph above the authorized speed. While the exact speed at which the engineer might have effectively braked train 6205, given all the variables in this instance, has not been determined by investigators, the Safety Board concluded that some speed-based safeguard might have enabled the engineer to exercise greater control over the Kelso accident train. The Safety Board considers that the UP's decision to implement the "plus 5 mph and stop" rule specified above is a step in the right direction. Nevertheless, the Safety Board considers that this narrowly defined order may not be sufficient to address the broad range of safety margin issues raised by this accident.

The Kelso accident underscored how important dynamic braking has become to safe operations in steep-grade areas. The railroad industry maintains that dynamic braking is a noncritical feature. Railroads have claimed that dynamic brakes are not required for safety or train control and that the main purposes of dynamic brake use are fuel economy and maintenance reduction. Because regulations require that trains be safely handled with the air brake system alone, railroads do not acknowledge that dynamic brakes have become an important safety and train-handling feature. Actual railroad rules and train-handling routines, however, indicate that, in practice, dynamic brakes have become essential to train handling. Despite railroad industry claims, current industry practices make the use of dynamic brakes necessary to safe operation. During the Kelso accident, the train accelerated beyond its stopping speed very rapidly (within 30 seconds) after dynamic brake loss. Therefore, the Safety Board concluded that railroads are operating trains in situations in which loss of dynamic braking will result in loss of train control.

The Safety Board has a history of recommendations regarding dynamic brakes. As a result of the investigation of an accident that took place at San Bernardino, California, in May 1989,[2] the Safety Board recommended that the Federal Railroad Administration (FRA):

> Revise regulations to require that if a locomotive unit is equipped with dynamic brakes, the dynamic brakes function. (R-90-024)

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[2]Railroad Accident Report — *Derailment of Southern Pacific Transportation Company Freight Train on May 12, 1989, and Subsequent Rupture of Calnev Pipeline on May 25, 1989, at San Bernardino, California* (NTSB/RAR-90/02).

On November 30, 1990, the FRA responded that it was reviewing the issue of regulations pertaining to dynamic brakes on locomotives and specified a range of responses available to the agency. The FRA, however, chose not to make a "definitive response" to the recommendation. On February 21, 1991, the Safety Board responded that the recommendation would remain classified "Open—Await Response" because of the FRA's lack of commitment to a specific action. Since then, the FRA has taken two actions in response to Safety Recommendation R-90-024, both of which were unsuccessful. First, the FRA issued a proposed rulemaking under the amendment of the Power Brake Law. The rulemaking was ultimately withdrawn. The FRA then placed the recommended action with its Railroad Safety Advisory Committee (RSAC) for handling. The RSAC was also unable to develop a satisfactory solution to the problem of providing for functioning dynamic brakes.

Reliable information on the status of a train's dynamic braking is also not available to the engineer. The engineer of the Kelso accident train had reason to question whether the dynamic braking system was operative on his train. Although he apparently did not consider this issue, a bad order tag indicating malfunctioning dynamic brakes had been left on one of the train's locomotives. This bad order tag could have caused the engineer to doubt the reliability of the train's dynamic braking system. He had (in accordance with UP requirements) performed a running dynamic brake test from MP 309.3 to MP 292, and the brakes had responded as expected, although the engineer still could not know whether they functioned as designed. Cima is located approximately 37 miles past this checkpoint, at MP 254.6. The engineer made no further dynamic braking tests before reaching Cima and so had no verified information on whether or how the dynamic brakes were functioning as the train neared this significant downgrade.

Although the engineer assumed (in accordance with UP policy) that the brakes were operational, he had no means of checking whether they were, aside from conducting additional tests. No equipment in the lead locomotive provided information on the train's dynamic braking status. The Safety Board therefore concluded that the engineer in the Kelso accident had no practical means of knowing if or how many of his locomotive units were properly working in dynamic braking immediately before the accident or when used.

In recent years, the railroad industry has developed an effective and reliable device to display the real-time dynamic braking performance of trailing locomotive units. Such a display would permit an engineer to modify his train-handling strategy based on the information it provided, before being surprised by the failure of a dynamic braking system that he had depended upon using. The Safety Board concluded that installing a device in the cab of each controlling locomotive to indicate the real-time condition of the dynamic brakes on each locomotive unit in the consist would give valuable information to the engineer on train dynamic braking capability at any given moment.

During the Kelso accident investigation, the Safety Board learned that UP personnel had not been formally trained on the appropriate way to set and use air brake pressure-retaining valves. Neither the conductor nor the engineer on the Kelso accident train had had any formal training on when or how to set the retainers, even though the practice was required by the UP and

important to braking safety in steep areas. Both crewmembers said they had gained all the knowledge they had about retainers through on-the-job training and experience.

In this instance, the conductor precharged the brake cylinders by setting most of the retainers while the train brakes were still applied. Investigators were unable to determine with certainty whether this action had any effect upon the unfolding of events in the Kelso accident. Such a precharge may or may not be significant, depending on conditions and future braking actions, since any additional braking will be added to that pressure already in the precharged cylinders.

The crucial point is that neither the conductor nor the engineer had a well-defined plan about when the retainers should be set or how they should be charged. Neither had a true appreciation of the significance of uncharged or precharged brake cylinders. Further, neither understood the proper use of retainers in controlling train speed through cycle braking. Because the engineer did not release the air brakes on the accident train's descent down Cima Hill, the retainers could not function as designed and were rendered effectively useless.

It seems self-evident that any procedure that is important enough to be required by a railroad should be well understood by railroad personnel and included in the railroad's formal training program. The Safety Board concluded that the significance of retainer-setting procedures, proper retainer use, and the various choices involved should be understood by train crewmembers and included in railroad training programs.

Finally, the Safety Board noted with concern that during this investigation repeated instances of procrastination, inattention, and ineffective action on the part of UP management regarding significant safety issues were uncovered. The 8 years of delay before the poorly placed MU shutdown switches were relocated, the operational reliance on dynamic braking without acknowledging dynamic braking to be a safety component of the braking system, the establishment of maximum train speeds that did not ensure safe operation in all situations, the recurrent misassignment of car weights, and the failure to train personnel responsible for setting and using retainers in correct procedures all indicated to the Safety Board that the UP may not be focusing sufficient corporate attention on operational safety.

The Safety Board understands that the UP has a general director of safety and appreciates that the UP has made organizational changes since the Kelso accident to put this official on a level closer to the UP president and chief operating officer. While the movement of the UP general director of safety one position closer to the president is progressive, the UP general director of safety still reports to, and is under the authority of, the executive vice president of operations. The Safety Board considers that the lead safety officer in the UP's management structure should report directly to the primary managerial authority to avoid possible conflicts of interest between business operations and safety. The potential to subordinate safety to economically expedient operating practices may be too great under such a corporate structure. Subordinating the position of safety officer to an operating officer also implies that safety is secondary to operations. The Safety Board therefore concluded that the UP general director of safety should report directly to the UP president and chief operating officer.

Based on the foregoing information, the National Transportation Safety Board issues the following recommendations to the Union Pacific Railroad:

Relocate and/or protect all safety-significant controls and switches in your locomotives so they cannot be inadvertently activated or deactivated. (R-98-10)

Reexamine your system of car weighing and car-consist weight reporting and take action to ensure that train consist weights reflect actual train weights. (R-98-11)

Reexamine your maximum authorized train speeds for safe operation of trains of all weights to establish new speed-based margins of safety that can be easily used by traincrews. (R-98-12)

Develop procedures to ensure that, before a train equipped with dynamic brakes is dispatched, all the dynamic brake systems on the locomotives are functioning properly. (R-98-13)

Equip all lead or controlling locomotive units with real-time displays capable of indicating to the engineer the dynamic brake condition on each trailing locomotive unit in the consist. (R-98-14)

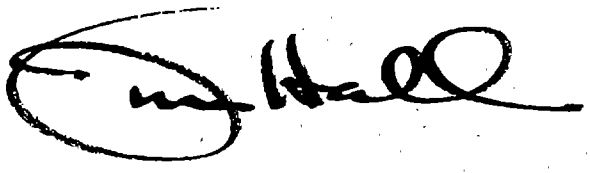
Implement formal training on the proper procedures for setting and using retainers for those traincrews that may be required to do so. (R-98-15)

Review the functions and responsibilities of the Union Pacific Railroad general director of safety and make any organizational changes necessary to ensure that this official: (1) reports directly to the Union Pacific Railroad president and chief operating officer; (2) is involved in all Union Pacific Railroad operational issues that could affect train, railroad, and personnel safety and; (3) has the authority to take effective safety actions throughout the Union Pacific Railroad. (R-98-16)

Also, the Safety Board issued Safety Recommendations R-98-1 through -7 to the Federal Railroad Administration and R-98-8 and -9 to the Association of American Railroads.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations R-98-10 through -16 in your reply. If you need additional information, you may call (202) 314-6438.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.



By: Jim Hall
Chairman